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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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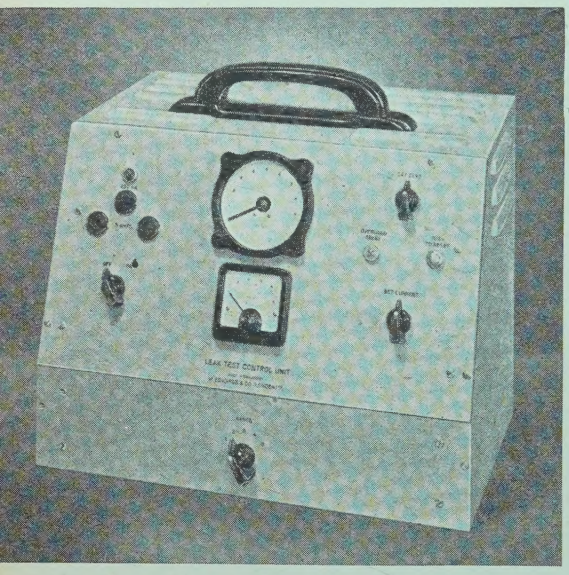
VOLUME 54 **OCTOBER 1951** NUMBER 646

A New Solution to an Old Problem



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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Mechanical testing
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Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplement published with the Index to Volume 53 (1950). Reprints of the List of Journals (1950) and the Supplement (1950) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

**Ann. Crimean Astrophys. Obs.*	*Annals of the Crimean Astrophysical Observatory.* [Abstracted by *Astronomical News Letter.*]
**Ann. Math.*	*Annals of Mathematics.* [Abstracted by *Mathematical Reviews.*]
**Gas Oil Pwr*	*Gas and Oil Power.* [Abstracted by Metropolitan-Vickers Electrical Co.]
**Glass Ind.*	*Glass Industry.* [Abstracted by *Photographic Abstracts.*]
**Izv. Akad. Nauk, SSSR, Ser. Geogr. Geofiz.*	*Izvestiya Akademii Nauk, SSSR, Seriya Geograficheskaya i Geofizicheskaya.* [Abstracted by *Meteorological Abstracts.*]
**Izv. Crimean Astrophys. Obs.*	*Izvestiya Crimean Astrophysical Observatory.* [Abstracted by *Astronomical News Letter.*]
**J. Met. Soc. Japan*	*Journal of the Meteorological Society of Japan.* [Abstracted by *Meteorological Abstracts.*]
Japan Sci. Rev.	*Japan Science Review.* The Engineering Society of Japan, The Japan Industrial Club, Marunouchi, Chiyoda-ku, Tokyo.
**Met. Monogr. Amer. Met. Soc.*	*Meteorological Monograph of the American Meteorological Society.* [Abstracted by *Meteorological Abstracts.*]
**Mitt. Inst. Geophys. E.T.H. Zürich*	*Mitteilungen aus dem Institut für Geophysik.* Eidgenossische Technische Hochschule Zürich. Clausiusstrasse 3, Zürich.
**Process Engrav. Mon.*	*Process Engravers Monthly.* [Abstracted by *Photographic Abstracts.*]
**Quart. J. Math. Oxford Ser.*	*Quarterly Journal of Mathematics, Oxford Second Series.* [Abstracted by *Mathematical Reviews.*]
**Sci. Rep. Tôhoku Univ., 5th Ser. Geophys.*	*Science Reports of Tôhoku University, Fifth Series—Geophysics.* [Abstracted by *Meteorological Abstracts.*]
Texas J. Sci.	*Texas Journal of Science.* The Texas Academy of Science, San Marcos, Texas.
**U.R.S.I. Proc. IXth Gen. Assembl.*	*U.R.S.I. Proceedings of the General Assembly.* The General Secretariat of U.R.S.I. [International Scientific Radio Union], 42 Rue des Minimes, Brussels.
**Wiss. Abh. Reichsamt Wetterdienst*	*Wissenschaftliche Abhandlungen der Reichsumt für Wetterdienst.* [Abstracted by *Meteorological Abstracts.*]

NEW JOURNALS

Nat. Phys. Lab., Not. Appl. Sci.	*National Physical Laboratory, Notes on Applied Science.* H.M. Stationery Office, Kingsway, W.C.2. No. 1 published Sept., 1951. A new series of handbooks.

NOTE

Scientia, Asso	Formerly entered as *Scientia.* Another journal of the same name, *Scientia, Valparaiso* is published by Universidad Tecnica, Federico Santa Maria Casilla 110-V, Valparaiso.

512.831

7444. On matrices whose eigenvalues are in arithmetic progression. P. T. LANDSBERG. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 3) 585–90 (1951).

512.94

7445. On a theorem of Brouwer. H. F. MATHIS. Letter in *J. Appl. Phys.*, **22**, 1084 (*Aug.*, 1951).

Brouwer has proved that it is impossible to find a vector function **A** which is defined on the bounding surface S of a finite 3-dimensional simply connected region with the property that (*a*) **A** is continuous everywhere on S, (*b*) **A** is everywhere tangent to S, and (*c*) $0 < |\mathbf{A}| < \infty$ everywhere on S.

Some applications are made of this theorem.

517.544

7446. Pointwise bounds for the solutions of certain boundary-value problems. J. L. SYNGE. *Proc. Roy. Soc. A*, **208**, 170–5 (*Aug.* 22, 1951).

The boundary-value problems considered are of the Dirichlet–Neumann type. The method now given for obtaining pointwise bounds of the solution and its derivatives is a compromise between the methods of Diaz and Greenberg on the one hand and Maple and Synge on the other; it appears to be simpler than either. The solution having been located on a hypercircle in function space, the pointwise bounds are obtained by taking the scalar product of the solution by certain vectors (Green's vectors). Divergence of integrals due to the poles of the Green functions is avoided by the use of regular functions matching the Green functions on the boundary (Diaz–Greenberg device) instead of by cutting out spheres from the domain (Maple–Synge device). A.

517.544.2

7447. The one-sided Green's function. K. S. MILLER. *J. Appl. Phys.*, **22**, 1054–7 (*Aug.*, 1951).

Let L be a linear differential operator of the nth order whose coefficients $p_i(x)$ are continuous in a semi-infinite interval $I : [a, \infty]$. A function $H(x, \zeta)$ is said to be a one-sided Green's function for the operator L if it satisfies the four conditions: (1) H is continuous and its first n derivatives with respect to x are continuous in I. (2) $H_\alpha(\zeta, \zeta) = 0$ for $\alpha = 0, 1, \ldots, n-2$. (3) $H_{n-1}(\zeta, \zeta) = 1/p_0(\zeta)$. (4) $LH = 0$. (The subscript on the H refers to partial differentiation with respect to the first argument, and $p_0(x)$ is the coefficient of d^n/dx^n in the expression for L.) It is shown that H is unique and if $u(x) = \int_a^x H(x, \zeta) f(\zeta) d\zeta$, then $Lu = f(x)$ and $u^{(\alpha)}(a) = 0$, $\alpha = 0, 1, \ldots, n-1$. Furthermore, if H is given, a fundamental system of solutions of $Lu = 0$ can be written down explicitly in terms of H and its derivatives evaluated at the end point a. The converse problem is trivial. Other properties of H are also considered, for example, its relation to the impulsive response of a network. A.

517.941.9

7448. Approximate eigensolutions of $\frac{d^2\phi}{dx^2} + \left(a + \frac{b}{x}e^{-x}\right)\phi = 0$. L. HULTHÉN AND K. V. LAURIKAINEN. *Rev. Mod. Phys.*, **23**, 1–9 (*Jan.*, 1951).

An exponential sum is used as trial function in the Rayleigh–Ritz method to find b and ϕ in terms of $\sqrt{(-a)}$, for the boundary conditions $\phi(0) = 0$ and $\phi(\infty) = 0$. The first 3 characteristic numbers are tabulated as found using 2, 3, and 4 terms in the trial sum. An indication of the error in the ϕ is given. The same method also enables series to be found for b and the coefficients of the trial sum, which are valid for small a or large a. Transformation of the equation and solution in power series enables the successive b's and the coefficients for ϕ to be found in the form of series which may be semi-convergent.

S. MICHAELSON

517.944

7449. Solutions of some partial differential equations (with tables). L. WEINBERG. *J. Franklin Inst.*, **252**, 43–62 (*July*, 1951).

The following equations are shown to be all special cases of the Helmholtz equation $\nabla^2\phi + \gamma^2\phi = 0$: Laplace, Poisson, diffusion, wave, damped-wave. Methods of finding solutions of the Helmholtz equation are demonstrated, which can thus be applied to the above; and tables of solutions are given for eight of the most commonly used co-ordinate systems.

518.5 : 548.735.4

A mechanical-electrical unit for calculating structure amplitudes. *See Abstr.* 8351

518.5 : 621.318.572

7450. Universal high-speed digital computers: serial computing circuits. F. C. WILLIAMS, A. A. ROBINSON AND T. KILBURN. *Instn Elect. Engrs, Paper* 1164, 14 *pp.* [*Early Proof Issue*].

Recent proposals for the construction of universal high-speed digital computing machines have led to a demand for computing circuits for use in such machines. The paper discusses circuits for use with numbers expressed in serial binary form. Special reference is made to a machine in which the storage of binary numbers is achieved by the use of charge-patterns on the screens of c.r.t. A.

518.5 : 621.318.572

7451. Some aspects of electrical computing. I. J. BELL. *Electronic Engng*, **23**, 213–16 (*June*, 1951).

A note on the standard simple methods of achieving addition, multiplication, resolution of polar to Cartesian co-ordinates, differentiation and the representation of non-linear functions by electrical methods. A. J. KENNEDY

519.2

7452. On the mean duration of random walks. W. WASOW. *J. Res. Nat. Bur. Stand.*, **46**, 462–71 (*June*, 1951).

The mean duration of a discrete random walk in a bounded domain is studied for general transition probability functions. The mean duration satisfies an integral equation which, for small mean step length, can be approximated by an elliptic differential equation. This leads to explicit inequalities for the mean duration in an important special case. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.56 : 535.511

7453. Note on the temperature effect of an interference polarizing filter. W. UNNO. Note in *Publ. Astron. Soc. Japan*, **2** (*No.* 1) 56–7 (1950).

It is found to be possible to construct an interference polarizing filter without temperature effect on the wavelength of a transmission band, when a composite plate of quartz and calcite is used. The ratio of quartz and calcite in a composite plate is to be nearly 9 : 1, and the optical axes of both crystals should be parallel. A.

522.56 : 535.511

7454. An interference filter for the study of the sun and its application. A. B. SEVERNY AND A. B. GILVARG. *Izv. Crimean Astrophys. Obs.*, **4** (*No.* 3) (1949). English Abstr. in *Astron. News Lett.* [*Harvard*] (*No.* 56) (*June* 20, 1951) *In Russian.*

Following the work of Lyot, Roberts, Waldmeier, Pettit and Evans, the authors have built an interference-polarization filter of Russian quartz. The optical theory, the practical problem of cutting the quartz and preparing the necessary pieces of polaroid film, the optical tests and the results of observations of prominences are described. The effective width of the filter is 1·8 Å. Experiments have also been conducted by crossing the filter with a Fabry etalon. In this manner the background of the sky becomes almost completely black.

ASTRONOMICAL NEWS LETTER

522.615

7455. A photoelectric stellar photometer with secondary electron multiplier. A. BEHR. *Z. Astrophys.*, **28** (*No.* 3) 254–61 (1951) *In German.*

Description with full technical details of a new photoelectric stellar photometer using a RCA multiplier of type 1P21. The construction aimed: (1) to be as simple as possible, thus reducing the possibility of failures during the observations, as well as the costs; (2) to achieve an accuracy of the order of $\pm$ 0·001 in photometrically best nights and for small zenith distances; (3) to give great measuring speed; (4) not to necessitate the help of a second observer. This instrument is at present working satisfactorily (in three different spectral ranges) at the Fraunhofer Institut at Freiburg. A. BEER

523.165 : 523.72

7456. Bibliography of extraterrestrial radio noise. M. E. STAHR. *Ithaca, N.Y., Cornell University* (1950) 117 *pp.*

This bibliography is part of the report of Commission V to the IXth General Assembly of the International Scientific Radio Union. There are nearly 300 entries, each with a short abstract, covering the period up to the end of 1949. Charts are given which summarize the wavelengths of observed radiations.

523.165 : 551.594.6

7457. Some observations of the variable 205 Mc/sec radiation of Cygnus A. C. L. SEEGER. *J. Geophys. Res.*, **56**, 239–58 (*June*, 1951).

A 205 Mc/s signal coming from the direction of the discrete radio source Cygnus A was observed on about 200 nights for runs of 2 to 10 hours' duration. The intensity was quite variable, the mean period of the variations being about $\frac{3}{4}$ min, in agreement with mean periods observed at much lower frequencies. Strong variations were observed at all altitude angles of the source. The signal appeared to rise above the undisturbed value much more than it fell below it, the upward excursions being several times the probable value of the undisturbed signal. A marked dependence of the variability of the signal on the altitude of the source was observed. The signal was always variable at source altitude angles $< 15°$. This must mean that an important part of the variability arises in the earth's atmosphere, presumably due to scattering by random inhomogeneities. Calculations indicate that ionospheric scattering may be a cause of fading of incoming radiation from outer space. It is suggested that for frequencies $<$ about 500 Mc/s the stronger radio stars are the most suitable sources of radio frequency radiation for use in studies of the transmission properties of the earth's atmosphere and should be of particular help in determining the physics of that part of the upper atmosphere inaccessible to normal ionospheric sounding techniques. A.

523.2

7458. The origin of the solar system. H. SPENCER JONES. *Endeavour*, **10**, 119–25 (*July*, 1951).

A brief account of (*a*) the special characteristics of the solar system which any theory of its origin must explain; (*b*) the various theories put forward since that of Kant, concluding with those of Hoyle, Alfven and Weizsäcker.

523.4

7459. Interplanetary matter. C. HOFFMEISTER. *Naturwissenschaften*, **38** (*No.* 10) 227–34 (1951) *In German.*

Interplanetary material may be broadly classified according to the phenomena associated with each of 6 classes of bodies, whose sizes range from 10^{7} to 10^{-6} cm, viz. class I (particle size, 10^{7}–10^{5} cm), comprises the minor planets; class II (10^{0}–10^{-2} cm), planetary meteorites; class III (10^{-1}–10^{-3}? cm), the zodiacal light; class IV ($\sim 10^{-2}$ cm), the solar corona; class V ($< 10^{-2}$ cm), striated structure of the night sky; class VI (10^{-6} cm), luminous night clouds. Compared with the mean density of interstellar matter (10^{-25} to 10^{-26} g cm^{-3}), interplanetary material attains densities of 10^{-21} g cm^{-3} in the neighbourhood of the earth's orbit, and 10^{-17} g cm^{-3} between the orbits of Mars and Jupiter.

D. R. BARBER

523.4

7460. The atmospheres of the planets. G. HERZBERG. *J. Roy. Astron. Soc. Can.*, **45**, 100–23 (*May–June*, 1951).

Reviews the present status of spectroscopic investigations of planetary atmospheres, including that of the earth. In the case of the earth's atmosphere the recent discovery of OH in the spectrum of the night sky by Meinel is discussed and its importance for the

phenomena in the upper atmosphere is pointed out. The spectroscopic detection of CO_2 in the atmospheres of Venus and Mars is described in some detail and laboratory investigations aiming at more accurate determinations of CO_2 content, pressure and temperature in these atmospheres are discussed. The observations of CH_4 absorption bands in the major planets and the satellite Titan are summarized and the possibility of detecting molecular hydrogen by means of the quadrupole rotation-vibration spectrum is outlined. It is probable that one of the unidentified features in the spectrum of Uranus and Neptune is due to the 3–0 band of the pressure-induced rotation-vibration spectrum of H_2. A.

523.46

7461. The stability of Saturn's rings. G. R. GOLDSBROUGH. *Philos. Trans A*, **244** (*No.* 874) 1–17 (1951).

Maxwell determined the conditions of stability of a single ring of small particles moving round a large primary. He also made some incomplete remarks on the effects of introducing a second ring. The present investigation considers in greater detail the stability of two rings of particles moving about a primary and subject to the gravitational attractions of the primary and of each other. It is shown that such a system, under conditions satisfied by the Saturnian system, is stable, the particles oscillating finitely about their mean positions. It is inferred that the Saturnian system, considered as a number of such rings, is therefore also stable. A.

523.46

7462. Tentative assessment of the dimensions of the particles and mass of the Saturn rings. M. S. BOBROV. *Dokl. Akad. Nauk., SSSR*, 77 (*No.* 4) 581–4 (1951) *In Russian.*

523.72

7463. The opacity of the solar photosphere between 6 700 Å and 23 000 Å. R. PEYTURAUX. *C.R. Acad. Sci., Paris*, **233**, 23–4 (*July* 2, 1951) *In French.*

Utilizing previous obsns. of spectral energy distribution at the centre of the solar disk [Abstr. 4049 (1951)] the obsd. variation of optical depth with wavelength at different photospheric levels is determined, and compared with theoretical values based on Chandrasekhar's work on H^- absorption. Agreement is satisfactory over the wavelength range considered. D. R. BARBER

523.74

7464. The structure of the solar atmosphere as deduced from limb-darkening measures. A. K. PIERCE AND L. H. ALLER. *Astrophys. J.*, **114**, 145–51 (*July*, 1951).

From solar limb-darkening measurements made at the McMath–Hulbert Observatory and from the intensity distribution at the centre of the disk the temperature at optical depth, τ_λ, is derived for a number of wavelengths. The theoretical k_λ, based on the negative H ion as the main source of opacity, appears to give an adequate interpretation of the solar limb-darkening measurements in the visual and i.r. region of the solar spectrum. The boundary temperature of the sun is about 4 500°. A.

523.745 : 550.385

7465. Control of the geomagnetic activity by the centres of solar activity distinguished by their radio-electric properties. J. F. DENISSE, J. L. STEINBERG AND S. ZISLER. *C.R. Acad. Sci., Paris*, **232**, 2290–2 (*June* 18, 1951) *In French.*

The radio energy emitted by the sun has been recorded daily on a frequency of 158 Mc/s since 1948 and this has been related to the passage of centres of solar activity across the central meridian of the sun. The centres are of two types, one of which produces an increase in radio energy and the other a decrease. Magnetic storms of a non-recurrent nature are associated with centres producing an increase in radio-energy and not with those producing a decrease. J. M. HOUGH

523.746

7466. A modification of long-term sunspot prediction. W. GLEISSBERG. *Z. Astrophys.*, **29** (*No.* 1) 1–8 (1951) *In German.*

The author's method of predicting the probable features of the next sunspot cycle is modified in such a manner that approximate average values of the characteristics of the next cycle—instead of their lower or upper limits with given probabilities—are obtained. In this case it is necessary to guess the next value of $t_r^{(4)}$, the four-cycle average of the reduced periods of rising. A.

523.746

7467. The average sunspot curve. W. GLEISSBERG. *Istanbul Univ. Fen. Fak. Mek., Ser. A*, **16**, 1–13 (*Jan.*, 1951) *In German.*

An average sunspot curve is deduced from all the sunspot cycles observed hitherto, and its properties are investigated. It is shown that the sunspot variations corresponding to this curve are represented by Stewart and Panofsky's formula very approximately. This result leads to some conclusions concerning the rates of the variation of Wolf's relative numbers arising from the formation of new spot groups and from the disintegration of existing groups. A.

523.75

7468. Observations of the behaviour of filaments during chromospheric eruptions. A. BRUZEK. *Z. Astrophys.*, **28** (*No.* 3) 277–95 (1951) *In German.*

Summary of the results of 2½ years' work (September, 1947–March, 1950) with Siedentopf's spectro-helioscope of the Austrian Solar Observatory at Kanzelhöhe. Two main groups are considered: (1) the "newly-born" eruption filaments; (2) the changes in old filaments. For group (1) statistical data are given for position, size, life-time, and the dependence on the intensity of the primary eruption. H. W. Newton's time-velocity diagrams, and M. A. Ellison's work, are confirmed in 90% of the recorded cases. Several typical examples of group (2) are discussed in detail: here the filament is found sometimes to return to its original state, and sometimes to resolve wholly or partly. It is pointed out that it is unlikely that the eruption itself produces the eruptive filament and its changes, but rather that both, eruption and filament, originate from some common cause. A. BEER

523.755

7469. On the theory of the solar corona. S. B. PICKELNER. *Ann. Crimean Astrophys. Obs.*, **5** (1950) English Abstr. in *Astron. News Lett.* [*Harvard*] No. 56 (*June* 20, 1951) *In Russian.*

Aims at constructing a theory in general outlines, not taking into consideration the fine structure and the local deviations from equilibrium. Application is made of the hydrodynamic equations to the outer corona, despite the great length of the free path and other difficulties. Some of the properties of the corona are explained from the point of the hydrostatic structure of the corona. The Reynolds number and the electrical field are determined. The dissipation has been estimated and the loss of 10^{18} g/year is given. Finally the author considers different mechanisms of "heating" the corona. He thinks that the most probable mechanism is that proposed by Shklovsky, by which the energy is transformed from the electrons to the protons.

ASTRONOMICAL NEWS LETTER

523.755

7470. A computation of the concentration of the coronal ions in the excited quantum states. I. S. SHKLOVSKY. *Ann. Crimean Astrophys. Obs.*, **5** (1950) English Abstr. in *Astron. News Lett.* [*Harvard*] (*No.* 56) (*June* 20, 1951) *In Russian.*

First of a series on the detailed investigation of the chemical composition and ionization. On the basis of the equivalent widths obtained by Grotarian, Shajn, Allen and Lyot, the author computes the concentration of the coronal ions in the excited states at different heights. At the same time he considers the difference in brightness of the corona observed at different epochs. In particular, he makes an attempt to determine the distribution of the electron concentration in the corona during the years 1936 and 1940, utilizing the Fraunhofer component of the corona's light. ASTRONOMICAL NEWS LETTER

523.755

7471. Computation of the concentration of the coronal ions in ground quantum states. I. S. SHKLOVSKY. *Ann. Crimean Astrophys. Obs.*, **5** (1950) English Abstr. in *Astron. News Lett.* [*Harvard*] (*No.* 56) (*June* 20, 1951) *In Russian.*

It appears that, if within the inner corona the excitation is produced by electron collisions, then in the outer corona the dominant part in the excitation of the green and red lines belongs to the radiation of the photosphere. The author then gives a theory of the relative intensities of different coronal lines belonging to one and the same ion (Fe XIII, Ni XV, Fe XI, Ni XIII). It is shown that the lines $\lambda\lambda$5694 and 5446 cannot belong to Ca XV. It is suggested that the regions of radiation of λ5694 in the corona are relatively cool. It is possible that the line 5 694 is caused by some transition of Ne VI.

ASTRONOMICAL NEWS LETTER

523.77

7472. Predictions of atomic lines in the infrared. J. W. SWENSSON. *Mem. Soc. Roy. Sci., Liège*, **11** (*No.* 1) 1–123 (1951) *In French.*

Contains an extensive table of wavelengths of atomic lines expected to be present in the solar spectrum between the wavelength limits, 1 μ and 15 μ. Wavelengths are calculated for the neutral atoms of H, C, Na, Mg, Al, Si, K, Ca, Ti and Fe. Frequencies, multiplet designations, and theoretical relative intensities are also included. D. R. BARBER

523.77

7473. On the calculation of the intensity distribution in Fraunhofer lines. II. Calculation of the weight functions for a given Kirchhoff–Planck function with an exponential term. H. HUNGER. *Z. Astrophys.*, **28** (*No.* 3) 245–53 (1951) *In German.*

For Pt I, see Abstr. 4636 (1950). Examination of the theory of the Fraunhofer lines under the assumption that the Kirchhoff–Planck function has the form $E(\tau) = 1 + \beta\tau + A \cdot e^{-\alpha\tau}$, ($\tau$ = optical depth for continuous absorption). The weight functions are graphically represented for various values of A, α and β, and compared with those following from the linear form $E(\tau) = 1 + \beta\tau$. Applications are made to the calculation of the centre-limb variation of lines for different stellar-models. A. BEER

523.77

7474. The new coronal line 5445 Å. M. WALDMEIER. *Z. Astrophys.*, **29** (*No.* 1) 29–32 (1951) *In German.*

Deals with the new coronal line discovered by the author at the wavelength 5 445 Å. This line appears very seldom and only above large sunspots of exceptional activity. Its behaviour is like that of the line 5 694 Å. The line is tentatively attributed to the transition $^3P_2$–$^3P_1$ of Ca XV. A.

523.77 : 539.153 : 535.338.3

Survey of published atomic spectra data. *See Abstr.* 7675

523.821

7475. A new correction formula for the determination of the magnitude differences between the components of double stars from visual estimates. P. BAIZE. *Ann. Astrophys.*, **14** (*No.* 1) 85–100 (1951) *In French.*

It is emphasized that these magnitude differences are usually larger than the photometrically determined ones, from which they may differ by even several magnitudes. This discrepancy, attributed to a contrast effect, is given as proportional to δ, the estimated magnitude difference, and inversely proportional to ρ, the distance of the two components. The author derives the formula: $\Delta m = \delta - 0{\cdot}2 \cdot (\delta + 0{\cdot}2\delta^2) \cdot \rho^{0{\cdot}8}$, and applies it to the 316 double stars (with $\rho < 5''$ and $\delta > 0^m{\cdot}5$), for which suitable observational material exists. The mean difference between eye and photometer of $+ 0^m{\cdot}72$ is now found to be practically removed. For 48% of the stars the p.e. is $0^m{\cdot}10$, for 43% it is $0^m{\cdot}18$, and only for the remaining 9% this method does not lead to an improvement. A. BEER

523.823 : 523.85

7476. Photoelectric studies. VIII. Positional effect in photomultipliers and some revised magnitudes in the North Polar Sequence and Harvard Region C 12. O. J. EGGEN. *Astrophys. J.*, **114**, 141–4 (*July*, 1951).

For Pt VII, see Abstr. 6704 (1951).

523.852

7477. Polarimetric investigations on the reflection nebula NGC 7023. W. GLIESE AND K. WALTER. *Z. Astrophys.*, **29** (*No.* 1) 94–100 (1951) *In German.*

The Potsdam 40 cm-reflector, combined with a Zeiss Bernotar polarization filter served for the determination of the polarization at 45 points of this nebula. The resulting values lie between 0 and 55 (± 3) %. A. BEER

523.852.22

7478. Ionized hydrogen regions in planetary nebulae. T. PAGE AND J. L. GREENSTEIN. *Astrophys. J.*, **114**, 98–105 (*July*, 1951).

A compilation of the best observational data for 9 planetary nebulae, after adjustment for internal consistency, shows that the linear dimensions of the bright rings are approximately the same as the calculated radii of the H II regions around the central stars. The relative sizes of 17 other nebulae, of all stages of excitation and ranging from 2″ to 70″ in apparent dia., confirm this result. The masses, spectral characteristics, and forms of the planetary nebulae are re-examined in the light of this conclusion. A.

523.852.22

7479. Negative hydrogen ions in planetary nebulae. J. L. GREENSTEIN AND T. PAGE. *Astrophys. J.*, **114**, 106–9 (*July*, 1951).

Continuous emission has been observed in the spectra of planetary nebulae which is apparently not due to H recombination. The transition zone between ionized and neutral H is a favourable region for the existence of H^-. The computed concentration of H^- relative to H is higher in planetary nebulae than in the sun. However, the capture continuum of H^- is too weak to account for the observed continuous spectrum of planetary nebulae. The bright regions of the nebulae are found to be transparent in H^-. A.

523.87

7480. Experimental data on H-emission. W. LOCHTE-HOLTGREVEN. Letter in *Naturwissenschaften*, **38** (*No.* 11) 258–9 (1951) *In German.*

523.872

7481. Polarization of the diffused light of N.G.C. 7023. M.-T. MARTEL. *C.R. Acad. Sci., Paris*, **232**, 2183–5 (*June* 11, 1951) *In French.*

A Lyot–Dollfus type polariscope [*C.R. Acad. Sci., Paris*, **228**, 1773 (*June* 8, 1949)], attached to the 120 cm telescope at Haute-Provence, has been used to photograph N.G.C. 7023 in yellow light (5 240 Å) on Eastman 103a-G emulsion. Photometric reductions from photometer tracings confirm that the polarization is radial c.f. central star, varying from 5% to 30% with position angle, and distance from the nucleus. Correction is applied for the weak polarization of the superposed night-sky light. Previous measures of polarization for this nebula by Henyey (1936) are supported. D. R. BARBER

523.873

7482. On the structure of the H.R. diagram [Zustandsdiagramm] of the stars. K. PILOWSKI. *Z. Astrophys.*, **28** (*No.* 3) 219–44 (1951) *In German.*

It is pointed out that the various sequences in the H.R. diagrams for the stars in the neighbourhood of the sun and for those in open clusters show very much the same arrangement and the same structure. Furthermore, that the "cosmic dispersion" of these sequences for the solar field stars is extremely small, just as is the case for the open clusters. The author attempts to derive a complete series of secondary sequences, and in doing so he modifies particularly the types of giants hitherto accepted. Within each of these sequences he finds a number of star accumulations, as well as distinct gaps. The latter can be connected by a family of straight lines: $\log R = \log \rho_n - 2 \log M$. For any ρ the relationships hold: $I/I_\odot = M^4/M_\odot^4 = \rho \cdot T^2/T_\odot^2 = \rho^2 \cdot R^{-2}/R_\odot^{-2}$, which are taken to represent lines of stellar evolution. (I = total radiation, M = mass, T = effective temperature, R = radius, ρ = parameter, $\odot$ = sun.) A. BEER

523.873

7483. Spectrophotometric study of three metallic-line stars. J. BERGER AND A.-M. FRINGANT. *C.R. Acad. Sci., Paris*, **232**, 2185–6 (*June* 11, 1951) *In French.*

The spectral classification of these stars is deduced from measures of the Balmer discontinuity and two gradients (above and below the Balmer limit), differenced from similar measures in η Aurigae. Differences are calibrated, as regards type, by measures in 6 normal stars of types A0–F8. Results for the metallic-line stars agree with previous classifications from metallic line intensities and not with those from the K line. D. L. EDWARDS

523.877

7484. On the radiation field of Be-stars. I. S. MIYAMOTO. *Japan. J. Astron.*, **1** (*No.* 1) 17–26 (1949).

Three-level and four-level problem for Be-atmospheres has been treated. These atmospheres are characterized by strong continuous radiations and large opacity for discrete lines. Inside the atmosphere, each transition, $i \rightleftarrows j$, maintains a separate balance. The flux of Lyman continuous, Balmer continuous radiation, etc., is constant and is equal to the incident radiation. Discrete radiations of Lyman series are weak with small amount of flux. Their intensity changes through the atmosphere in proportion to that of ultraviolet radiation. Subordinate lines such as Balmer discrete radiations have constant intensities with zero flux. The intensity of continuous radiations changes in proportion to the dilution factor, while discrete lines are independent of it. It has been shown that in Be-atmospheres the characteristic quantity for i–j radiation is that defined by the ratio of probability of continuous absorption $j \rightarrow c$ to the spontaneous transition $j \rightarrow i$. A.

523.877

7485. Internal structure and energy of the stars. E. VIDAL ABASCAL. *Bol. Radiactividad*, **23**, 170–88 (1950) *In Spanish.*

Discusses the state of the stellar-energy problem (1945). A summary in English is included. D. R. BARBER

523.877

7486. Contribution to the theory of spectral type. III. Construction of models for B-type stars. J.-C. PECKER. *Ann. Astrophys.*, **13** (*No.* 4) 433–58 (1950) *In French.*

For Pt II, see Abstr. 1589 (1951). A complete

discussion of the factors influencing the monochromatic and mean absorption coefficients is given, and a method for tabulating these quantities developed. The iterative method of Strömgren [*Astron. J.*, **53**, 107 (1948)] is used to develop two stellar models corresponding to spectral types B_1 and $B_{1\cdot5}$. The different characteristics of their continuous spectra are tabulated. It is shown that for this spectral-type region, Kuiper's temperature scale underestimates the stellar temperatures, and consequently for spectral type $B_{1\cdot5}$ the bolometric correction is underestimated by about $\frac{1}{2}$ mag. M. W. OVENDEN

523.877

7487. Contribution to the theory of spectral type. IV. The formation of lines in stellar spectra. J.-C. PECKER. *Ann. Astrophys.*, **14** (*No.* 1) 115–51 (1951) *In French.*

The equivalent width (w) of a spectrum line is represented by $w \sim \int_0^\infty g(\tau)b(\tau)\Psi x(\tau),\ a(\tau)d\tau$, where $g(\tau)$ is the *weight function* depending only upon the continuous absorption of the stellar atmosphere, $b(\tau)$ and $x(\tau)$ are functions of the ionization and excitation of the atom absorbing the line, Ψ is a *saturation function* which varies from 1 at the surface of the star to 0 at great depths in the atmosphere (the rate of decrease of Ψ being more rapid for strong lines, Ψ being constant = 1 for weak lines), and the function $a(\tau)$ is the ratio of the damping constant to Doppler width of the line. The calculation of w can be made for very general conditions with an accuracy not smaller than 2%. Examples of the application of the formula to curves of growth, abundance determinations, interpretation of centre-limb variation of certain solar lines, etc., are cited. An appendix gives tables useful for the calculation of the various functions involved. M. W. OVENDEN

523.877

7488. Contribution to the theory of spectral type. V. The "blanketing effect" and the structure of the solar photosphere. J.-C. PECKER. *Ann. Astrophys.*, **14** (*No.* 1) 152–75 (1951) *In French.*

The solar lines are classified, and reduced to a certain number of type-lines, according to their wavelengths and the ionization and excitation potentials of the absorbing atoms. The fraction of the total flux absorbed by each type-line is calculated as a function of optical depth, and the flux absorbed by all the lines together is found for various optical depths; the influence of this variation on a solar model which is in radiative equilibrium to a first approximation is discussed. A photospheric temperature of 4 200° is thus found, while observations indicate a temperature of 4 800°. It is suggested that such a difference might be due to errors introduced in the interpretation of observations by the assumption of perfect sphericity of the photospheric layers; the effect of "roughening" of the photosphere due to granulation is examined; agreement between theory and observation for the neighbourhood of the solar surface can be obtained by this modification, but disagreement continues to exist at greater depths. M. W. OVENDEN

523.877

7489. On the average condition and the physical properties of stellar atmospheres in their dependence on effective temperature and gravity. E. VITENSE. *Z. Astrophys.*, **29** (*No.* 1) 73–93 (1951) *In German.*

Calculation, for a number of wavelengths, of electron pressure, gas pressure, radiation temperature, and absorption coefficients; with contributions to the theory of the Balmer lines, the variation of line intensities, the bolometric corrections, and the problem of convection in stellar atmospheres. A. BEER

523.877

7490. Intermediate atmospheres in closed binaries. A. KRANJC. *Mem. Soc. Astron. Ital.*, **22** (*No.* 2) 131–5 (1951) *In Italian.*

It is shown that the corpuscular radiation emitted by a closed binary must be concentrated near that Lagrange point which is intermediate in the linear solution of the three bodies restricted problem. It is also shown that it is possible to explain in this way the presence of a hydrogen cloud which may generate the emission lines in UX Mon. A.

523.877

7491. The distribution of line-width-deduced rotational velocities for A-stars. K. WALTER. *Ann. Astrophys.*, **29** (*No.* 1) 9–25 (1951) *In German.*

Frequency-distribution curves are given for line-widths (4 481 Å : MgII), and rotational velocities of 413 A-stars of various Harvard sub-types. It is pointed out that the rotational velocity curves exhibit two frequency maxima, corresponding to equatorial velocities of *c.* 50 and 150 km/sec. D. R. BARBER

523.877

7492. Electrostatic fields in white dwarf stars. F. C. AULUCK AND L. S. KOTHARI. *Proc. Nat. Inst. Sci. India*, **17**, 15–20 (*Jan.–Feb.*, 1951).

The usual derivation of the mass radius relation of a white dwarf star does not make an explicit reference to the electrostatic field. This is done in the present paper and it is shown that the electric field severely controls the properties of the equilibrium configuration. A.

523.877

7493. On the construction of models with a discontinuity of the molecular weight for stars with given values of their mass, radius and luminosity. U. R. BURMAN. *Proc. Nat. Inst. Sci. India*, **17**, 57–65 (*Jan.–Feb.*, 1951).

The problem of the determination of the chemical composition of a star from a knowledge of its mass, radius and luminosity, is studied from the point of view of Bethe's energy generation law, and on the basis of a convective-radiative model with a sharp discontinuity of composition (and hence of molecular weight) across the interface. It is found that just as many equations governing the structure of the star can be framed as there are unknown quantities required for a complete specification of the chemical composition both inside and outside the convective core. Stability consideration sets an upper limit to the size of the convective core for the correct model. It should be noted, however, that the equations

referred to above should not always furnish a significant solution compatible with all the conditions of the problem. In fact, the case of the star α Cen A worked out in this paper leads to no admissible solution. A.

523.877

7494. The Balmer discontinuity for some "extended-atmosphere" stars. J. BERGER, R. CANAVAGGIA, D. CHALONGE AND A.-M. FRINGANT. *C.R. Acad. Sci., Paris*, **232**, 2398–400 (*June* 25, 1951) *In French.*

From a spectrophotometric study of the 4 "shell" stars, ζ Tau, BD. + 44°4014, BD. + 29°3982r and HD. 190 073, it is concluded that the presence of a Balmer discontinuity much greater than that of normal stars (or super-giants) of the same spectral type, forms a simple means of recognition.

D. R. BARBER

523.877

7495. Hydrogen exhaustion and explosions of stars. G. GAMOW. Letter in *Nature, Lond.*, **168**, 72–3 (*July* 14, 1951).

The suggestion is made that the point, $M = 0$, on the Russell–Hertzsprung diagram marks the divergence from the main-sequence of two distinctive stellar groups: (i) the "swollen" pulsating variables, and "red-giant" types; and (ii) the "shrunken" Wolf–Rayet "white dwarf," and exploding (nova) types. The two groups represent stars whose initial store of H has been depleted. Possible processes leading to periodic convectional instability are discussed, and suggest a mechanism for stars of U Geminorum type.

D. R. BARBER

525.35

7496. Theory of the rotation of the earth having three unequal principal moments of inertia. N. SEKIGUCHI. *Japan J. Astron.*, **1** (*No.* 1) 99–122 (1949).

525.35

7497. Movement of the pole of the earth from 1939 to 1949. A. YA. ORLOV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 4) 649–53 (1951) *In Russian.*

526.3

7498. Treatise on geodesy (2nd ed.). Vol. 1. Triangulation. No. 1. Mathematical basis of geodesy. Terrestrial operations. P. TARDI AND G. LACLAVÈRE. *Paris, Gauthier-Villars* (1951) xvii + 387 *pp. In French.*

A comprehensive treatise on instruments and procedures of terrestrial operations in geodesy, giving theoretical and instrumental details needed by the practising surveyor. Part 1 is a summary of necessary mathematics, geometry of the ellipse and ellipsoid and theory of errors and method of least squares, including the elements of the theory of probability. Part II includes descriptions of modern French, Swiss, British and American theodolites, with mention of a new process for the reproduction of divided circles by the cathodic deposition of metal on glass through an accurately divided mask and the photographic registering theodolite; a full account of the means of estimating and allowing for theodolite errors; the international standard metre and the reasons for continuing to use it as the geodetic standard instead of the wavelength of the red Cd line (particularly the dependence of the wavelength on the conditions of emission); the possibility that wavelength of a line from Hg^{198} may provide a better standard being mentioned; the standardization and use of Invar wires and tapes for base measurements; optical interference methods of base measurement and recent experiments on the use of radar and of the time of propagation of a light wave for the measurement of distance; traverse operations (polygonation) are only briefly treated; organization and carrying out of geodetic operations; atmospheric refraction effect in height determination and the estimation of the effect it has on the measurement of zenith distance and on spirit levelling; precise levelling staves, tide gauges and fundamental bench marks; the barometric measurement of height. A. H. COOK

526.5 : 512.831

7499. Application of calculus of matrices to method of least squares with special reference to geodetic calculations. A. BJERHAMMAR. *K. Tekn. Högsk. Handl.* (*No.* 49) 86 *pp.* (1951).

The reciprocal of a rectangular matrix is defined and the two unit matrices obtained by pre- or post-multiplication of the matrix with the reciprocal are discussed. The solution of a rectangular matrix equation with the number of equations greater than the number of unknowns is not unique, but it is shown that if the matrix equation is a set of observation equations $\mathbf{AX} = \mathbf{L} + \mathbf{V}$ ($\mathbf{X}$, matrix of unknowns, $\mathbf{L}$ of observed quantities, $\mathbf{V}$ of residuals) the sum of squares of residuals, $\mathbf{VV}'$, is a minimum for $\mathbf{X} = \mathbf{A}^{-1}\mathbf{L}$. Adjustment by means of condition equations is treated by a similar method. By partitioning matrices the effects on the residuals of carrying out the adjustment in stages or groups are discussed. Lagrange's method of undetermined multipliers and the discussion of the errors of the unknowns are also put into matrix form. The last part of the paper, roughly half the whole, is concerned with numerical methods. A method is given for the direct solution of the observation matrix equation without the intermediate formation of the normal equations by partitioning into triangular matrices. A. H. COOK

PHYSICS 53

53.081

7500. A unit of wave-number. W. BLADERGROEN; C. CANDLER. Letters in *Nature, Lond.*, **167**, 1075 (*June* 30, 1951).

See Abstr. 6014 (1951). The name "balmer" is suggested by Bladergroen as justified from the historical point of view. Candler, in reply, agrees that "balmer" or "rydberg" are equally suitable. S. WEINTROUB

53.081.6

7501. Erratum: A re-evaluation of the fundamental atomic constants. J. A. BEARDEN AND H. M. WATTS. Letter in *Phys. Rev.*, **83**, 457 (*July* 15, 1951).

See Abstr. 2356 (1951). The value of the Bohr magneton should be changed to read: $(9{\cdot}27100 \pm 0{\cdot}00017) \times 10^{-21}$ erg. gauss^{-1}.

FUNDAMENTALS 530.1

530.12

7502. The new Einstein theory and the equations of motion. L. INFELD. *Acta Phys. Polon.*, **10** (*No.* 3–4) 283–93 (1951).

It is known that the field equations of general relativity theory determine motion without any additional equations. If, besides the gravitational field, the electromagnetic field is assumed, then the Lorentz equations of motion are obtained. The Lorentz equations are not obtained by means of the new approximation method; the equations of motion are essentially the same as in general relativity theory, if an electromagnetic field is absent. A.

530.12

7503. A strange consequence of the equations of Einstein's new unified theory. A. GAMBA. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **10,** 472–4 (*June*, 1951) *In Italian.*

Bandyopadhyay's claim [Abstr. 6016 (1951)] that, for static symmetric solutions, the particle mass and charge cannot both be non-zero is criticized as involving an incorrect identification of the electromagnetic tensor [see also Abstr. 7504 (1951)], but a suitably modified solution obtained independently of Schrödinger's field equations is still found to imply zero charge. R. A. NEWING

530.12

7504. The point-charge in the non-symmetric field theory. A. PAPAPETROU AND E. SCHRÖDINGER. Letter in *Nature, Lond.*, **168,** 40–1 (*July* 7, 1951).

It is contended that a previous remark [Abstr. 6016 (1951)] does not correctly interpret a calculation of the authors' [*Proc. Roy. Irish Acad.*, **51A,** 163 (1947)]. J. R. MADDOX

530.12

7505. On the mutual action between gravitational and electromagnetic fields. P. UDESCHINI. *Atti. Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **10,** 390–4 (*May*, 1951) *In Italian.*

It is shown that Schrödinger's solution [Abstr. 6019 (1951)] of Einstein's new field equations, in which a weak electromagnetic field gives rise to a 2nd-order gravitational field, may be deduced from the author's 2nd-order approximation to the field equations [Abstr. 5063 (1951)]. It is also shown that a 1st-order gravitational field will not influence a 2nd-order electromagnetic field. R. A. NEWING

530.12

7506. Existence and uniqueness theorems for the equations of the Jordan–Thiry unified theory. Y. FOURÈS-BRUHAT. *C.R. Acad. Sci., Paris,* **232,** 1800–2 (*May* 16, 1951) *In French.*

Methods used for existence theorems in general relativity [Abstr. 3587 (1948)] are here applied to Thiry's 5-dimensional theory [Abstr. 3749 (1949)]. R. A. NEWING

530.14

7507. Electro-magnetic theory of gravitation. N. S. JAPOLSKY. *Pakistan J. Sci. Res.*, **2,** 1–27 (*Jan.*, 1950).

The present theory of gravitation is based on the whirl theory of fundamental particles [see Abstr. 8475 (1950)], according to which the "material" fundamental particles such as the electron, the proton, the positron, etc., as well as the photons, are certain forms of Maxwell's e.m. waves, called the "e.m. whirls." The gravitation is the result of comparatively small forces of interaction following the inverse square law, the existence of which was revealed at the inception of the whirl theory in 1935, acting within the limitations of very low frequency precessions of particles ("micro-precessions") resulting from very small but essentially inevitable asymmetry of particles, causing a minute motion of centre of gravity of particles (micro-motion). The micro-motion produces large-scale de Broglie's waves ("macro-waves") which co-ordinate the micro-motion in different celestial bodies. The macro-waves of the solar system form a single complex, the study of which makes it possible to correlate the motions of planets round the sun, their rotation about their respective axes, the gravitational constant, the magnetic fields of the planets, and their secular precessions. In particular, it allows the magnetic moment of terrestrial magnetism to be calculated, and the result agrees with the observed data within 2%. A.

530.145

7508. "Integro-causation" in convergent quantum field theory. F. J. BELINFANTE. *Progr. Theor. Phys.*, **6,** 202–6 (*March–April*, 1951) *In Esperanto.*

Field theory requires the exclusion of "unallowable" Feynman diagrams, that is, diagrams containing self-energy parts, vertex parts, etc. Omitting these, small changes are made in the factors of the matrix element integrands corresponding to each vertex or line of the diagram. A prediction of $\Psi(t_2)$ from $\Psi(t_1)$ requires integration of the allowable diagrams over the time between t_1 and t_2 only. The result is a paradoxical inequality. It is then shown that this unequality was to be expected, if one takes into account that Ψ has no objective meaning, but is determined by the experimental evidence going into the initial value for Ψ. A general equation presents an "integro-casual" relation between prediction at t and knowledge at t_0, as contrasted to the "immediate casual" relation between $\Psi(t)$ and $\Psi(t + dt)$ in the ordinary Schrödinger theory. The present theory leads in its differential form to an "interaction operator with a memory," $B_{t0}(t)$. A.

530.145

7509. The nature of the scale factor occurring in the quantum-mechanical treatment of systems by the variational method. P. TORKINGTON. Letter in *J. Chem. Phys.*, **19,** 979–80 (*July*, 1951).

530.145

7510. An alternative covariant formulation of the electron-positron theory. O. COSTA DE BEAUREGARD. Letter in *Phys. Rev.*, **83,** 182 (*July* 1, 1951).

A corrected summary of the integral equations for the characteristic function of the energy [Abstr. 4116 (1951)]. G. J. KYNCH

530.145

7511. Some remarks on the non-local field theory. Z. TOKUOKA AND Y. KATAYAMA. Letter in *Progr. Theor. Phys.*, **6,** 132–3 (*Jan.–Feb.*, 1951).

It is shown that, assuming that it is possible to

restrict the spin freedom, the Yukawa non-local field theory does not lead in general to a finite self-energy for each particle of the theory. R. H. DALITZ

530.145

7512. On the difference between local and non-local fields. H. YUKAWA. Letter in *Progr. Theor. Phys.*, **6**, 133–4 (*Jan.–Feb.*, 1951).

The claim of Hara and Shimazu [Abstr. 5098 (1951)] that non-local fields can be reduced to local fields by a unitary transformation is not correct, when there is interaction between non-local fields. R. H. DALITZ

530.145

7513. The covariant methods of analytical mechanics in the general theory of fields, linear or otherwise. B. KWAL. *J. Phys. Radium*, **12**, 534–42 (*April*, 1951) *In French.*

The general theory of fields is developed covariantly from a Lagrangian, not necessarily bilinear, both for tensor and spinor fields. Generally a distinction is necessary between the fields in the Lagrangian and the secondary polarization fields which occur in the Euler equations. For charged particles, an external field is introduced, gauge invariance discussed and charge and current densities obtained. The energy tensor is derived and canonical equations obtained in terms of a scalar Hamiltonian. An equation of Hamilton–Jacobi type is also obtained from several points of view, so that all traditional methods in analytic mechanics have their covariant counterpart in the non-linear theory. R. H. DALITZ

530.145

7514. Manifolds of electromagnetism. J. GÉHÉNIAU. *Bull. Acad. Roy. Belge Cl. Sci.*, **37** (*No.* 4) 324–32 (1951) *In French.*

The manifolds defined by the properties of given e.m. fields are analysed: the most general manifold is shown locally symplectic and the Maxwell equations have a simple form in this space. The relation of field $H_{\alpha\beta}$ and induction $K_{\mu\nu}$ defines a tensor $p_{\alpha\beta,\,\mu\nu}$—the most general form is found for $p_{\alpha\beta,\,\mu\nu}$ which allows a general invariant quadratic relation between H and K. R. H. DALITZ

530.145

7515. Some notes on the quantisation of real fields. G. MARX. Letter in *Acta Phys. Hungarica*, **1** (*No.* 1) 104–6 (1951).

The view that corpuscles are described by complex eigenfunctions [N. Kemmer, *Proc. Roy. Soc. A*, **173**, 91 (1939)] is supplemented by the remark that only second quantization, not first quantization, appears to be applicable to entities having real eigenfunctions. P. T. LANDSBERG

530.145

7516. On the covariant formalism of the quantum theory of fields. II. R. UTIYAMA. *Progr. Theor. Phys.*, **6**, 65–95 (*Jan.–Feb.*, 1951).

The methods of Pt I [Abstr. 66 (1951)] are not applicable unmodified when the electromagnetic field is included. Here a new quantity is introduced as canonical conjugate to the scalar potential and quantization is carried out by the Heisenberg–Pauli method. The formalism is shown covariant under co-ordinate and gauge transformations. However, the Lorentz condition is here a q-number relation. The equations are transformed to interaction representation, whence the Tomonaga–Schwinger equations are obtained. The theory is proved equivalent to the usual theory and its applicability to the vector meson field is discussed. R. H. DALITZ

530.145

7517. On second quantization. II. Positron theory. J. G. VALATIN. *J. Phys. Radium*, **12**, 542–9 (*April*, 1951) *In French.*

For Pt I see Abstr. 5078 (1951). Positron states are represented by the antisymmetric tensors of the space $R_+ + R_-^*$, $R_\pm$ being the subspaces spanned by the positive and negative energy states of a free Dirac electron, $R_\pm^*$ being the dual of $R_\pm$. All operators M are then broken up into a sum of finite operators acting within and between the subspaces representing positron and electron states respectively. The formalism is illustrated by explicitly writing out the equation $u = M/c$. R. H. DALITZ

530.145

7518. On a covariant method of local quantization in the general theory of fields. B. KWAL. Letter in *J. Phys. Radium*, **12**, 572 (*April*, 1951) *In French.*

A modified quantization method is outlined, applicable to a generalized field theory such as that suggested by the author [Abstr. 2382 (1951)].

R. H. DALITZ

530.145

7519. The methods of second quantization and of configuration space in the relativistic theory of systems of particles. III. Derivation of relativistic equations for interacting particles. M. JEAN. *C.R. Acad. Sci., Paris*, **232**, 2405–7 (*June* 25, 1951) *In French.*

For Parts I–II see Abstr. 5086 (1951). The procedure is sketched for writing down the infinite set of coupled configuration-space Schrödinger equations which correspond to given total charge, given the Hamiltonian in the second-quantized theory, and is used to obtain, in momentum variables and to order g^2, the principal Schrödinger equation describing two nucleons interacting weakly through a meson field.

R. H. DALITZ

530.145

7520. On the problem of covariance in quantum electrodynamics. I. J. YUKAWA AND H. UMEZAWA. *Progr. Theor. Phys.*, **6**, 112–21 (*Jan.–Feb.*, 1951).

The Pais–Epstein [Abstr. 3753 (1950)] formula for the self-stress of a particle is verified. It is shown that the self-stress from the vertex graph vanishes in C-meson theory, though infinite in the Schwinger theory. However, the vacuum polarization graph leads to infinite self-stress. This difficulty is discussed.

R. H. DALITZ

530.145

7521. Matter and quantum properties of electromagnetic wave-fields. H. W. KÖNIG. *Acta Phys. Austriaca*, **4** (*No.* 4) 405–30 (1951) *In German.*

A classical study of the velocity of flow of e.m. energy, leading to a classical interpretation of the quantum nature of light which allows the possibility of a small rest-mass for the photon. R. H. DALITZ

530.145

7522. Non-local quantum electrodynamics. J. RAYSKI. *Acta Phys. Polon.*, **10** (*No.* 3–4) 300–2 (1951).

A non-local spinor field theory is investigated, a current vector being defined according to a correspondence rule. The field equations describing its interaction with the electromagnetic field are integral equations, invariant under a restricted gauge group only. The *S*-matrix may be calculated by the method of Yang [Abstr. 94 (1951)] a simple rule is given for transcription of the *S*-matrix of the usual theory to that of this non-local theory. R. H. DALITZ

530.145

7523. Heisenberg operators in quantum electrodynamics. II. F. J. DYSON. *Phys. Rev.*, **83**, 608–27 (*Aug.* 1, 1951).

For Pt I, see Abstr. 5090 (1951). The equations of motion of quantum electrodynamics are set up in the interaction representation, using a formalism due to Gupta. A new representation, called the intermediate representation, is defined by constructing explicitly a unitary operator $S(t)$, which transforms the state-vector of the interaction representation into the state-vector of the new representation. The intermediate representation is intermediate in behaviour between the interaction and Heisenberg representations. In it the l.f. changes in the state of a system are represented by changes in the state-vector, as in the interaction representation, while the h.f. fluctuations are represented by the time-variation of the field operators, as in the Heisenberg representation. The aim is to prove that the intermediate representation provides a complete and divergence-free formulation of quantum electrodynamics, with a divergence-free Schrödinger equation which describes accurately the behaviour of any physical system. In this paper the mathematical technique is developed which will enable the divergences to be eliminated from the Schrödinger equation. It is applied first to the analysis of the electromagnetic potential operators. It is proved that any Fourier component of an electromagnetic potential operator in the intermediate representation is divergence-free after renormalizations have been consistently carried out. The cancellation of the divergences by appropriate compensating terms arising from $S(t)$ is an extremely intricate process, which could only be tested by carrying through the calculations in detail. It is explained how Heisenberg operators are to be regarded as a special limiting case of intermediate representation operators. It follows from the preceding analysis, that averages over finite space-time regions of Heisenberg field operators in quantum electrodynamics are divergence-free after renormalization. A.

530.145

7524. The scattering of light by light. R. KARPLUS AND M. NEUMAN. *Phys. Rev.*, **83**, 776–84 (*Aug.* 15, 1951).

Cross-sections for several processes involving electromagnetic fields in a nonlinear manner are derived from the electrodynamic scattering matrix and are expressed in terms of the 4th-order nonlinear vacuum polarization tensor. The differential cross-section for the scattering of light by light is calculated as a function of energy and angle. Numerical values are given for scattering at zero and at 90° in the centre-of-mass system. Near 1·75 MeV the forward scattering cross-section has its largest value of $4{\cdot}1\times10^{-31}$ cm²/sterad, while the maximum right-angle scattering takes place near 0·7 MeV with a cross-section of $2{\cdot}8\times10^{-31}$ cm²/sterad, all for unpolarized radiation. Numerical results are also given for scattering at the above angles between circularly polarized states. The conclusions in this paper agree with all the results previously calculated for special cases.

530.145

7525. Quantum electrodynamics with nonvanishing photon mass. F. COESTER. *Phys. Rev.*, **83**, 798–800 (*Aug.* 15, 1951).

A theory of neutral particles with spin one and arbitrary mass κ in interaction with electrons is developed in such a form that all observable results go over continuously into the corresponding results of ordinary quantum electrodynamics as $\kappa\to0$. A.

530.145

7526. On a system of fields free of divergences of the mass-renormalization type. J. RAYSKI AND J. RZEWUSKI. *Acta Phys. Polon.*, **10** (*No.* 3–4) 159–72 (1951).

It is shown that a system of 4 different fields consisting of one photon, one electron, one *C*-meson, and two charged scalar meson fields is free of divergences of the mass-renormalization type. A.

530.145

7527. On the interaction of particles in Feynman's theory. J. RZEWUSKI. *Acta Phys. Polon.*, **10** (No. 3–4) 294–6 (1951).

The form of the current density associated with change of nucleon state is derived from the assumptions that it is linear in initial and final states, that a nucleon satisfies Dirac equation in the field due to this current and that the resultant covariant interaction operator is symmetrical between two nucleons. R. H. DALITZ

530.145

7528. The *S*-matrix and radiation damping. S. N. GUPTA. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 2) 454–6 (1951).

Dyson's *S*-matrix is thrown into another form by the use of the Cayley equation,

$$S = (1 - \tfrac{1}{2}iK)/(1 + \tfrac{1}{2}iK)$$

K is obtained as an infinite expansion and is related to Dyson's permutation integrals. It is shown that the effect of radiation damping is made more apparent by this expansion, and that each finite part of the expansion is unitary. J. R. MADDOX

530.145

7529. On radiation reaction in the Wheeler–Feynman reformulation of electron theory. H. STEINWEDEL. *Z. Naturforsch.*, **6a**, 173–7 (*April*, 1951) *In German.*

The divergenceless reformulation of classical electron theory given by Wheeler and Feynman [Abstr. 1681 (1949) 3752 (1950)] is modified so that only retarded fields occur in the equations of motion. The retarded self-field of the electron yields at once the electro-

magnetic mass and the well-known radiation reaction force. Further, higher time-derivatives occur in the equations of motion, with a resulting possibility for the avoidance of the "runaway solutions" occurring for the equations discussed by Eliezer [Abstr. 32 (1948)]. R. H. DALITZ

530.145

7530. Bipolar expansion of Coulombic potentials. R. J. BUEHLER AND J. O. HIRSCHFELDER. *Phys. Rev.*, **83**, 628–33 (*Aug.* 1, 1951).

The calculation classically or quantum mechanically of the Coulombic interaction between two charge distributions is greatly simplified by use of the bipolar expansion:

$$\frac{1}{r_{12}} = \sum_{n_1, n_2, m} B_{n1, n2}{}^{|m|}(r_1, r_2; R) P_{n1}{}^{|m|} (\cos\theta_1) P_{n2}{}^{|m|}(\cos\theta_2) \exp[im(\phi_2 - \phi_1)].$$

Here (r_1, θ_1, ϕ_1) are the spherical coordinates at a point referred to the centre of the first charge distribution and (r_2, θ_2, ϕ_2) are the spherical coordinates of another point referred to the centre of the second distribution; R is the separation between the centres; r_{12} is the distance between the two points; $P_n{}^{|m|}(\cos\theta)$ are the associated Legendre polynomials; the $B_{n1, n2}{}^{|m|}(r_1, r_2; R)$ are expansion coefficients given in this paper. There are 4 functional forms for these coefficients, depending on the ratios of r_1, r_2 and R. Three of these have been given recently by Carlson and Rushbrooke. For quantum-mechanical problems involving over-lapping charge distributions the fourth case, $|r_1 - r_2| \leqslant R \leqslant r_1 + r_2$, must be considered as well. Here the coefficients have a more complicated form. The solution is expressed as an integral, and a number of the coefficients are tabulated. The expansion permits a simple evaluation of the two centre Coulombic integrals arising in a large variety of quantum-mechanical problems. A.

530.145

7531. A note on the U operator. M. NEUMAN. Letter in *Phys. Rev.*, **83**, 671 (*Aug.* 1, 1951).

The unitaritiness of the operator $U(t)$ connecting Heisenberg and interaction representations is claimed to be an assumption lying outside the theory, though $U(\infty)$ is here proven unitary. R. H. DALITZ

530.145

7532. On soft photon emission in radiation processes. H. PRIMAKOFF AND F. VILLARS. Letter in *Phys. Rev.*, **83**, 686 (*Aug.* 1, 1951).

Calculation of the mean energy carried off by the Bloch–Nordsieck photons [*Phys. Rev.*, **52**, 54–9 (*July* 15, 1937)] in pair annihilation and in X-ray emission and absorption shows that, to one part in a million, these soft photons do not enter into the energy conservation relation. R. H. DALITZ

530.145 : 538.569 : 548.7

On the interaction between the radiation field and ionic crystals. *See Abstr.* 8346

530.145 : 539.172

7533. Singular potentials and the theory of the effective range. K. A. BRUECKNER AND F. LOW. Letter in *Phys. Rev.*, **83**, 461 (*July* 15, 1951).

The effective range is calculated for a potential $V = V_0 e^{-\mu r}[B/\mu r + 1/(\mu r)^3]$ for $r >$ proton Compton wavelength, $1/\mu$ being the meson Compton wavelength. It is concluded that the singular potential gives the observed effective range only if long-tailed ($B > 1$) or if there is strong repulsion at short distances. R. H. DALITZ

530.145 : 539.185

7534. The electron-neutron interaction. L. L. FOLDY. Letter in *Phys. Rev.*, **83**, 688 (*Aug.* 1, 1951).

A Pauli interaction term which represents the observed magnetic moment of the neutron is shown to be able to account at once for the observed electron-neutron interaction. An explanation is also suggested for discrepancies existing between various meson-theory calculations of this interaction. R. H. DALITZ

530.145 : 539.185

7535. Multiple elastic scattering and radiation damping. I. H. EKSTEIN. *Phys. Rev.*, **83**, 721–9 (*Aug.* 15, 1951).

The problem of potential scattering by a number of similar scatterers is reformulated so that the potential is eliminated from the equations and replaced by a function which characterizes the scattering properties of the individual scatterer. The resulting equations can be used for the more general case where the single-scattering process is not describable by a potential, e.g., absorption or—to a certain extent—inelastic scattering. A solution of the equations by iteration is considered and compared with Born's approximation. As an application, the second approximation for the scattering of thermal neutron by a small crystal is calculated. A.

530.145

7536. On the possibility of a complex structure for particles of spin different from $\frac{1}{2}$. L. DE BROGLIE. *J. Phys. Radium*, **12**, 509–16 (*April*, 1951) *In French.*

The motion of the mass centre of the product of the fusion of two particles of spin $\frac{1}{2}$ can be described by the equations of a particle of spin 1, so that the spin properties are transferred to the mass-centre. It is possible to find a wave-equation describing the internal motion, and to show that the particle suffers a Lorentz contraction. These results can be extended to particles of higher spin. G. J. KYNCH

530.145

7537. A study of the system formed by combination of two Dirac-particles. M. A. TONNELAT. *J. Phys. Radium*, **12**, 516–20 (*April*, 1951) *In French.*

The solutions of the equation describing two Dirac particles interacting by means of a potential with a general dependence on the Dirac matrices are obtained, both for singlet and triplet combinations. R. H. DALITZ

530.145

7538. Some considerations on gauge transformations and the definition of Hertz vectors in the theory of Maxwellian particles of spin 1. B. KWAL AND L. DE BROGLIE. *C.R. Acad. Sci., Paris*, **232**, 2056–8 (*June* 4, 1951) *In French.*

530.145

7539. Relativistically invariant homogeneous canonical formalism with higher derivatives. J. WEYSSENHOFF. Letter in *Acta Phys. Polon.*, **10** (*No.* 3–4) 303–5 (1951).

The equations of motion derived from a Lagrangian

with second derivatives are expressed in invariant and canonical form, using a parametric specification of the space-time co-ordinates. The theory is illustrated by a Lagrangian describing a classical spinning particle. R. H. DALITZ

530.145

7540. Note on the analytic continuation of the *S*-matrix. N. G. VAN KAMPEN. *Phil. Mag.*, **42**, 851–5 (*Aug.*, 1951).

It is shown that methods which try to avoid the redundant poles are not likely to be successful. On the other hand, the analytic continuation of the *S*-matrix is an ill-defined procedure, which cannot be applied until more properties of the *S*-matrix are known. The redundant poles are caused by the use of the asymptotic expression of the wave function instead of its actual value and have no physical meaning. A.

530.145

7541. The self-energy of scalar mesons in interaction with nuclei. J. RZEWUSKI. *Acta. Phys. Polon.*, **10** (*No.* 3–4) 141–50 (1951).

The meson self-energy is calculated using the scalar and scalar-product coupling. In the second case the self-energy operator contains derivatives of the meson fields. It is shown that this operator can be removed by changing the transformation function from the Schrödinger to the interaction representation and that this change is equivalent to a change in mass, i.e. to a mass renormalization. A.

530.145

7542. Remarks on some non-linear effects in field theory. I. J. RAYSKI. *Acta Phys. Polon.*, **10** (*No.* 3–4) 151–8 (1951).

The scattering of a neutral scalar particle by another particle of the same kind and the spontaneous breaking up of a neutral particle is studied under the assumption of an interaction with a complex scalar field. These problems are analogous to the scattering of light by light and to the spontaneous breaking up of photons. The calculations are based on the Feynman–Dyson technique of solving problems in quantum field theory. The calculation of the scattering of light by light (coupling with pseudoscalar charged particles) will appear as Pt II. A.

530.145

7543. Non linear effects in the theory of quantized fields. II. J. RAYSKI AND B. ŚREDNIAWA. *Acta Phys. Polon.*, **10** (*No.* 3–4) 207–12 (1951).

For Pt I, see preceding Abstr. Elements of the Heisenberg *S*-matrix for the process of scattering of light by light under the assumption of interaction with charged scalar meson field are calculated. The calculations are based on Feynman and Dyson's invariant technique of calculations, described in the first part. A.

530.145

7544. An algebraic theory of the density matrix. II. T. NISHIYAMA. *Progr. Theor. Phys.*, **6**, 1–16 (*Jan.–Feb.*, 1951).

For Pt I, see Abstr. 6035 (1951). A study of the algebraic structure of permutation operators, with special reference to properties of exchange operators concerning spin and isotopic spin and without assumption of group theory theorems. Principal appendices discuss representations of creation and annihilation operators and of the symmetric algebra of order 24. R. H. DALITZ

530.145

7545. Mesonic processes in two-nucleon system. Y. FUJIMOTO AND Y. YAMAGUCHI. *Progr. Theor. Phys.*, **6**, 166–74 (*March–April*, 1951).

The production and annihilation of a meson in a two-nucleon system are discussed phenomenologically, leaving at first the matrix elements for production and annihilation undetermined. It is shown that when the matrix element is adjusted properly, the main features of the observed meson spectrum can be accounted for by the distortion of the nucleon wave functions by the nuclear and Coulomb forces. For the wave function of two nucleons, the method of distorted wave with shape-independent approximation is used. The calculation can be applied only to low-energy phenomena, such as meson production near the threshold. Some experiments on artificial mesons fulfil this condition. There may be a possibility that the mesonic interaction is "non-local," or the wave function of a meson is largely distorted, but these cases are not considered. A.

530.145

7546. Pseudoscalar meson theory and ground state of deuteron. G. ARAKI AND Y. MORI. *Progr. Theor. Phys.*, **6**, 188–92 (*March–April*, 1951).

It is examined whether the two-nucleon adiabatic potential predicted by the pseudoscalar meson theory correctly describes the ground state of the deuteron or not, assuming an effective form of the potential. The energy eigenvalue and the corresponding eigenfunction are calculated according to the variational method. By comparing the theoretical binding energy of the deuteron with the observed value, the value of the coupling constant of mesons with nucleons is estimated to be $g^2 = 0{\cdot}2$. The theoretical values of the electric quadrupole moment and the dipole magnetic moment of the deuteron are compared with experiment. The theory is in agreement with experiment in a very rough approximation. A.

530.145

7547. On the absorption of the negative π-meson by deuteron. S. OGAWA, E. YAMADA AND Y. NAGAHARA. *Progr. Theor. Phys.*, **6**, 227–37 (*March–April*, 1951).

The various processes which are induced by the absorption of the negative π-meson by the deuteron are analysed. The negative π-meson is assumed to be bound in *K*-orbit. The results indicate that, as for the model of meson, the vector and the pseudovector types are not favourable. The π-meson of pseudoscalar type is most favourable. A.

530.145

7548. On a simplification in the calculation of the cross-sections in the process of particle collisions. G. PETIAU. Letter in *J. Phys. Radium*, **12**, 565 (*April*, 1951) *In French.*

The evaluation of spurs is simplified by using a

5th suffix which absorbs the mass term into the energy-momentum symbol. The range of matrices $\gamma^5\gamma^\mu$, $\gamma^5(\mu = 1, \ldots 4)$ is used. G. J. KYNCH

530.145

7549. On the question of causality in the quantum theory of elementary particles. W. HEISENBERG. *Z. Naturforsch.*, **6a**, 281–4 (*June*, 1951) *In German.*

In the author's *S*-matrix theory of elementary particles [Abstr. 2109 (1944), 835 (1951)] it is investigated to what extent one can limit to small space-time regions the deviations from causal behaviour which occur in this theory, according to Fierz [Abstr. 2373 (1951)]. Further arguments for such deviations from causal behaviour are discussed within a general theory of elementary particles. R. H. DALITZ

530.145

7550. On Stueckelberg's treatment of the vector meson field. S. N. GUPTA. *Proc. Phys. Soc., Lond. A*, **64**, 695–9 (*Aug.*, 1951).

Stueckelberg's treatment of the vector meson field is investigated, and is found to involve difficulties similar to those of Fermi's treatment of the radiation field. It is shown that these difficulties may be removed by the same procedure as has already been applied to the radiation field in an earlier paper [Abstr. 6997 (1951)], which involves the use of an indefinite metric and a modification of the supplementary condition. A.

530.145

7551. Outline of a general theory of atomic collisions. I. Collisions of one particle with a system of particles. R. KOŁODZIEJSKI. *Acta Phys. Polon.*, **10** (*No.* 3–4) 223–46 (1951).

An outline of the general non-relativistic theory of collisions of one particle with a system of particles is given, based on the most simple example of collisions with a H atom. The well-known approximations follow from the general theory after introducing certain simplifications. The meaning of the phase shift for the wave function of an elastically scattered particle is extended to the case of unelastically scattered particles, and a general formula for the phase shift is deduced. In the case of large velocities of the colliding particle, the general formula for the phase shift tends to become the phase shift formula given by the Born approximation. For elastic scattering by "spherically symmetric rigid potentials" the general phase shift formula is identical with the well-known phase shift formula for this special case. Some new procedures are given for approximate calculations of scattering processes in the case of medium velocities of the scattered particles. The main advantages of the proposed theory are summarized. A.

530.145

7552. Statistical interpretation of the Klein–Gordon equation. J. RZEWUSKI. *Acta Phys. Polon.*, **10** (*No.* 3–4) 296–9 (1951).

For the equation $(\Box^2 - \kappa^2)\psi = g\phi\psi$, a transition amplitude connecting a state at $t = -\infty$ and a state at $t = +\infty$ is derived. R. H. DALITZ

530.145

7553. Does the de Broglie wave-equation satisfy the relativity principle? V. S. VRKLJAN. *Glasn. Mat-fiz. Astron.*, **5** (*No.* 4–5) 198–201 (1951) *In Croatian.*

The de Broglie equation for spin 1 [L. de Broglie, Particules à spin (1943)], though of non-covariant appearance, is shown to have invariant form w.r.t. Lorentz transformation. R. H. DALITZ

530.145

7554. Perturbation of virtual states. J. HUMBLET. *Bull. Soc. Roy. Sci. Liège*, **20**, 323–6 (*April*, 1951) *In French.*

The first-order perturbation energy of virtual states defined by Siegert's condition is obtained, explicitly, in terms of unperturbed quantities. J. R. MADDOX

530.145

7555. On perturbation theory in quantum mechanics. I. Discontinuous spectra. M. SCHÖNBERG. *Nuovo Cim.*, **8**, 243–70 (*April*, 1951) *In French.*

The total Hamiltonian is written $H = J + I$ (not, as usual, $H = H_0 + V$) where $J\phi_l^\circ = E_l\phi_l$ and E_l is an eigenvalue of H whenever ϕ_l° is an eigenfunction of H_0. The development follows the familiar spectral resolution of linear transformations in Hilbert space. In the stationary case two sets of relations for the perturbed eigenvalues and functions are obtained—these are related to those of Brillouin and Lennard–Jones. The application to time-dependent situations (Dirac) is accomplished by "hyperoperaters" (C) which effect transformations ($A \to B$) of the operators in the space according to

$$\langle l|B|l'\rangle = \sum_{k,\,k}\sum \langle l, l'|C|k, k'\rangle\langle k|A|k'\rangle$$

The spectral resolution of these leads to results analogous to the familiar ones, and to a discussion of the *S*-matrix. J. R. MADDOX

530.145

7556. On the scattering of mesons by nucleons. M. CINI AND L. A. RADICATI. *Nuovo Cim.*, **8**, 317–25 (*May*, 1951) *In Italian.*

Differential and total cross-sections are given for scattering of scalar and pseudoscalar mesons by nucleons in 2nd order perturbation theory using Feynman's method. Collision with charge exchange is always more probable than ordinary collision in the pseudoscalar case, while for low energies (< 2 nucleon masses) the contrary is true for the scalar case. This fact should provide a way of distinguishing between the two cases, comparing with the experiments on artificially produced mesons. At present no conclusion can be drawn. Extreme relativistic formulas are the same for both scalar and pseudoscalar case. A.

530.145

7557. On the fourth uncertainty relation. G. RIDEAU. *C.R. Acad. Sci., Paris*, **232**, 2007–9 (*May* 28, 1951) *In French.*

The uncertainty relationship between time and energy is obtained directly from integral equations previously derived [Abstr. 6039–40 (1951)], and its limitations are discussed. G. J. KYNCH

530.145

7558. Application of symbolic calculus to the solution of the perturbation method of Dirac. M. FABRE DE LA RIPELLE. *C.R. Acad. Sci., Paris,* **232,** 2403–5 (*June* 25, 1951) *In French.*

The Laplace transform is given of the time-dependent equations of Dirac's "variation of parameters" method, and its interpretation considered.

R. H. DALITZ

530.145

7559. Momentum representation of the Coulomb scattering wave functions. E. GUTH AND C. J. MULLIN. Letter in *Phys. Rev.*, **83,** 667 (*Aug.* 1, 1951).

The momentum transform of the wave-function representing non-relativistic Coulomb scattering of an incident plane wave is given and its application to the approximate evaluation of matrix elements is outlined.

R. H. DALITZ

530.145

7560. A remark on the conventional perturbation theory. S.-S. WU. *Phys. Rev.*, **83,** 730–4 (*Aug.* 15, 1951).

It is shown that Dyson's *S*-matrix theory can also be attained by the perturbation method used in the conventional field theory formalism. A.

530.145 : 537.122

7561. Interaction between an electron and a positron. V. B. BERESTETSKIĬ AND L. D. LANDAU. *Guide Russ. Sci. Period Lit.* (*Brookhaven*) **4,** 33–9 (*Feb.*, 1951).

Full English translation of the article abstracted as Abstr. 1504 (1950).

530.145 : 539.13

7562. The torsional oscillator. W. HANUS. *Acta Phys. Polon.*, **10** (*No.* 3–4) 173–92 (1951).

The Schrödinger equation for an asymmetrical top in an external field is considered. Restricting attention to oscillations near the position of equilibrium the general equation is reduced to that of an anisotropic harmonic oscillator. The approximations made are tested by treating the neglected terms by perturbation theory and, for the case of naphthalene, by comparison with the experimental data on the "external Raman effect." R. H. DALITZ

530.145.6

7563. Determination of the phase of the wave function in particle scattering: correction. G. F. DRUKAREV. *J. Exp. Theor. Phys., USSR,* **20,** 1056 (*Nov.*, 1950) *In Russian.*

See Abstr. 5258 (1949).

530.145.6

7564. Curvilinear momenta in quantum mechanics. R. CADE. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 2) 451–3 (1951).

Subject to certain differentiability conditions, these may be defined in all cases. J. R. MADDOX

530.145.6

7565. The scattering of a particle in a potential-well. H. KOPPE. *Z. Naturforsch.*, **6a,** 229–32 (*May*, 1951).

Laplace transformation of the time-dependent wave-function yields an inhomogeneous equation which is solved with the aid of the Green's function. Reminiscent of *S*-matrix theory. J. R. MADDOX

530.162

7566. Thermodynamics of the Bose gas. YU. B. RUMER. *J. Exp. Theor. Phys., USSR,* **20,** 807–10 (*Sept.*, 1950) *In Russian.*

Using more general assumptions than are usual concerning the energetic spectra of particles, an investigation is made of phenomena of "condensation" of the Bose gas and the influence of internal parameters on the "condensation" temperature.

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530.162

7567. On a treatment of imperfect gas after Fermi's Model. III. M. DUTTA. *Proc. Nat. Inst. Sci. India,* **17,** 27–38 (*Jan.–Feb.*, 1951).

For Pt II, see *ibid.*, 14, 163 (1948). The statistical theory of imperfect gases, already developed in the previous papers by the application of a principle of exclusion, a special form of that of Pauli–Fermi, and, of method of Fermi, has been extended to the case of general field of forces. The equation of state, yielding Dieterici's equation up to first approximation, has been obtained by taking into account a general type of field of force, and the finite size of particles. This has been done by dividing the configurational space into different potential layers and also into cells of volume equal to the finite volume of the particles, as is done in the discussion of Fermi-Dirac statistics. Here, as in the previous papers, the distributions for the configuration-space and, for the momenta-space have been considered separately. It has been shown that some discussions hold good, and the same results can be obtained without splitting up phase-space into configuration space and momenta-space. A.

530.162

7568. Note on the Bose–Einstein integral functions. J. E. ROBINSON. Letter in *Phys. Rev.*, **83,** 678 (*Aug.* 1, 1951).

Using a simple treatment, expansions of the Bose–Einstein integral functions $F(\sigma, \alpha)$ are obtained for all σ and small positive α. T. C. TOYE

530.162

7569. Brownian motion in a gas of noninteracting molecules. M. S. GREEN. *J. Chem. Phys.*, **19,** 1036–46 (*Aug.*, 1951).

The Brownian motion of a hard spherical particle in a gas whose molecules interact only with the particle but not with each other is considered from three points of view. (*a*) the generalized Fokker–Planck equation for the process is derived by the classical method of Lord Rayleigh. (*b*) the hypothesis of the phenomenonological theory of Brownian motion that the distribution of changes of momentum of the particle is normal is investigated with some mathematical rigour. (*c*) the formula for the friction constant recently given by Kirkwood is applied to this case. It is found that the plateau value in this formula exists in this case and that the value obtained agrees with Rayleigh's method. The hypothesis of the phenomenonological theory is found to be justified for times long enough for many collisions to have taken place. The theoretical formula for the friction constant is compared with Millikan's data for the friction constant for oil droplets in air at low pressures. It is found to agree with Millikan's data

with respect to the form of the dependence on density and temperature. The theoretical values for hard spheres are somewhat lower than the data for oil droplets. A.

530.162 : 536.79

7570. Remarks on the entropy constant and the third law of thermodynamics. W. MUND. *Bull. Acad. Roy. Belge. Cl. Sci.*, **37** (*No.* 3) 207–12 (1951) *In French.*

It is possible to deal with the probability of state, without a detailed consideration of the molecular distribution of a perfect monatomic gas, or evaluation of the partition function, in such a way as to make apparent the connection between the thermodynamic and statistical definitions of entropy and to clarify the significance of the third law of thermodynamics.

F. E. HOARE

530.162 : 539.13 : 538.222

Statistics of a linear paramagnetic macromolecule. *See Abstr.* 8038

530.162 : 539.133

7571. Stochastic processes and dispersion of configurations of linked events. C.-M. TCHEN. *J. Res. Nat. Bur. Stand.*, **46**, 480–8 (*June*, 1951).

By the use of a function for the transition probability, as introduced by Kolmogoroff in diffusion problems with continuous motion (the so-called continuous stochastic processes), the dispersion of the configurations of linked events is studied. A long-chain molecule of irregular configurations, representing configurations of events linked in a time sequence, is chosen as a model. Attention is given in particular to the inversion of the dispersion law of stochastic processes, and to the interactions between nearest neighbours. A very elementary application is given to the perturbance on the distribution function for the configurations of a chain molecule, as a result of interactions by other neighbour chains. A.

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531.36

7572. On the possibility of a modification and extension of Eötvös's rotated balance experiment. P. SELÉNYI. *Acta Phys. Hungarica*, **1** (*No.* 1) 75–83 (1951) *In German.*

The balance, or better the balance beam, is to be suspended horizontally by a vertical torsion fibre and, in place of Eötvös's uniform rotation, the balance is allowed to perform oscillations only about the rest position. It is shown mathematically, assuming resonance conditions and following Eötvös, that (*a*) with the N–S direction as rest position beam oscillations are produced by the torsional oscillations as for uniform rotation of the balance (Eötvös effect) and vice-versa; (*b*) with the E–W direction as rest position the beam oscillations are of twice the frequency of the torsional and are too small to be effective. Thus (*b*) can be used to test whether the observed effect in (*a*) is truly an Eötvös effect. Eötvös considered a component only of the Coriolis forces and his work is thus strictly limited to the neighbourhood of the Equator. The equations of motion of the undamped torsion-suspended beam at the Equator, with rest position in the meridian, are derived taking into account the Coriolis forces which enter because of the vertical oscillations of the beam and it is shown that the balance behaves exactly as a Foucault pendulum at the Poles. The Coriolis forces act as a coupling between the torsional and beam oscillations and the energy of the system exchanges periodically between the two modes of motion. S. WEINTROUB

531.383

7573. Study of the motion of a Fleuriais gyroscope. G. HEINRICH. *Öst. Ingen.-Arch.*, **5** (*No.* 2) 138–54 (1951).

The motion of a symmetrical gyroscope running out freely in a spherical bearing on a pivot is investigated under the supposition of a semi-liquid friction between pivot and bearing cup. The dependances of the elevation moment, of the braking action by the pivot friction and of the additional precession moment of the gyro axis inclination to the perpendicular line are calculated, the distribution of the pressure being assumed to be according to Hertz. The results are represented by diagrams. A.

531.51 : 530.12

7574. The problem of two finite bodies in the second approximation to the gravitation theory of Einstein. I. G. FIKHTENGOLTS. *J. Exp. Theor. Phys., USSR*, **20**, 824–33 (*Sept.*, 1950) *In Russian.*

The basis of this work is the Lagrange form of the equations of motion. All calculations using the work of Fok are carried out in the harmonic (inertial) system of coordinates. Equations are given for the motion of the centre of inertia and for the relative motion of two finite masses. Integrals, analogous to the two-body problem in the Newton approximation, were obtained for these equations. In the approximation used, the vectoral velocity is not a strictly constant magnitude but is rather a function which varies slightly and depends on the distance between the bodies and their velocities. An equation is obtained for the trajectory of the relative motion of two arbitrary bodies. In particular, in the case of motion of a small mass around a large one, the equation of the trajectory simplifies with respect to the usual one due to the use of a harmonic system of coordinates.

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531.552

7575. Effect of cross-wind on a projectile. K. PENNYCUICK. Letter in *Nature, Lond.*, **168**, 41 (*July* 7, 1951).

By integrating the equation of motion of a projectile along the trajectory, an expression for the drift, z, of the projectile due to a cross wind of velocity w ft/sec can be derived in the form $z = 0{\cdot}000067\, wvt^2d^2f_R/m$ ft, where m = mass of the projectile (lbs), x = range (ft), r = radius of projectile (ft), f_R = drag coefficient, t = the time of flight (sec), and v = the muzzle velocity of the projectile relative to air (ft/sec). This formula is easy to apply, is valid for short times of flight, gives better results at subsonic

than at supersonic velocities, and is easy to apply, compared with the usual formula $z = w(t - x/v)$.

J. S. G. THOMAS

MECHANICAL MEASUREMENTS 531.7

531.715.1 : 535.417

7576. Interferometric calibration of precision screws and control of ruling engines. G. R. HARRISON AND J. E. ARCHER. *J. Opt. Soc. Amer.*, **41**, 495–503 (*Aug.*, 1951).

A new device is described with which screws of any length can be calibrated rapidly for both periodic and cumulative errors in terms of interference fringes. It can also be used to plot correction cams to remove fixed errors of translation or rotation, and to monitor the operation of an engine while ruling diffraction gratings or scales, correcting by automatic feedback differences between the actual carriage position and its proper position as shown by an optical interference field. This "Commensurator," (i.e. for overcoming the incommensurability of the wavelength of the light used for calibration and the lead of a screw) consists principally of a screw drive system, eight-figure dials, and a generator, geared together in ratios that can be controlled to one part in 10^8. Fringes produced by a Michelson interferometer are changed photoelectrically to a wave train that measures translation to within 0·1 μin. A second wave train of almost identical average frequency is produced by the Commensurator generator to measure screw rotation, and the two trains are continuously compared by means of a phase-sensitive amplifier and motor to within 1/100 cycle or fringe. Corrections for changes in barometric pressure or in temperature can be introduced during operation. Transient as well as fixed errors of run and period can be automatically compensated for. If the fringe system is lost, it can be re-established from the Commensurator record, so that controlled ruling of gratings wider than any available coherent fringe-field appears possible. A.

531.74 : 535.8 : 526.93

7577. Electro-optical measurement of angles by a photometric method. H. BENDER. *Optik*, **8** (*No.* 5) 206–23 (1951) *In German.*

A detailed description of the apparatus necessary for surveying operations using i.r. light for its greater penetrating properties. The light is detected by a photocell, and the visual alignment of a telescope is replaced by an adjustment similar to a photometric setting. An accuracy of 4″ of arc is claimed under favourable conditions. N. CORCORAN

531.752

7578. Present position of microbalance technique. E. SINGER. *J. Phys. Radium*, **12**, 554–62 (*April*, 1951) *In French.*

A review. Under the separate headings of microbalances with gallows and fixed balance arm, and torsional, flexural and other microbalances, various forms described in the literature during the past fifty years are briefly discussed and shown diagrammatically. 37 refs. S. WEINTROUB

531.76 : 621.791.736.31 : 621.316.72

7579. A timing control for small spot welders. M. H. NICHOLS. *Rev. Sci. Instrum.*, **22**, 372–3 (*June*, 1951).

531.761 : 621.317.39

7580. A millisecond timer. J. M. STURTEVANT. *Rev. Sci. Instrum.*, **22**, 359–62 (*June*, 1951).

A device giving a time delay up to 10 sec duration (in steps of $\frac{1}{10}$ sec) and having a precision of 1 millisec. is described. Rough determination of interval is made by time of rise of voltage from a positive-feedback saw-tooth generator to a level selected by an accurate potentiometer. Precise triggering is provided by pulses of 0·1 and 1 sec interval from decade scalers (capable of automatic resetting after each operation) fed from a 1 kc/s tuning-fork-controlled oscillator; the pulses are thus accurate to 0·001 sec. A simplified form of the device can be employed as a trigger-operated stopclock for timing periods of any length. Detailed circuits, and adjustment and c.r.o. monitoring procedures, are given.

A. J. KENNEDY

531.767 : 621.317.49

7581. A bar-magnet velocity meter. T. A. PERLS AND E. BUCHMANN. *Rev. Sci. Instrum.*, **22**, 475–81 (*July*, 1951).

A meter for vibratory and shock motions has been investigated both theoretically and experimentally. The instrument consists of a long bar magnet which moves relative to a long coil. It is shown that Alnico V combines all the best features required of the magnet material, when compared experimentally with a magnet made of hardened tool steel and theoretically with other grades of Alnico, Cunife and tungsten steel. Different methods are discussed for installing the velocity meter. A.

531.787

7582. A simple pressure recorder. J. TADAYON. Letter in *Rev. Sci. Instrum.*, **22**, 534–5 (*July*, 1951).

The height of liquid in one limb of a U-tube is directly shadow-photographed on to a slowly moving band of document copying photographic paper.

531.787 : 621.317.79

7583. A null-reading absolute manometer. D. ALPERT, C. G. MATLAND AND A. O. MCCOUBREY. *Rev. Sci. Instrum.*, **22**, 370–1 (*June*, 1951).

A Kovar chamber, divided into two by a 0·005-in corrugated Kovar pressure-sensitive diaphragm, connects on the one side with the gas system under study, and on the other, past a capacitive probe connected electrically to a capacitance bridge, with a liquid manometer. For null measurements the pressure on the manometer side is adjusted with air until the diaphragm assumes its equilibrium position as indicated by its capacitance with the probe. The elastic limit of the diaphragm is reached with a pressure difference of 50 mm Hg approx., and a difference of 10^{-2} mm Hg can be detected. The instrument is

suitable for pure gases or condensable vapours, and can be outgassed at high temperatures.

S. WEINTROUB

MECHANICS OF FLUIDS 532

532.13 : 541.123.2

7584. Viscosity of binary liquid mixtures. N. L. BALÁZS. *Rec. Trav. Chim. Pays. Bas.*, **70**, 412–18 (*May*, 1951).

An approximate theoretical deduction is given for the viscosity coefficient of binary liquid mixtures combining a modified theory of Eyring for viscous flow with the statistical model due to Guggenheim for strictly regular solutions, using the Bragg–Williams approximation. A.

532.14

7585. Density and molecular volume of heavy water between 20° and 100°C. R. SCHRADER AND K. WIRTZ. Note in *Z. Naturforsch.*, **6a**, 220–1 (*April*, 1951) *In German.*

Presents the results of new determinations of (1) density of D_2O and D_2O/H_2O density ratio for the interval 20–100°C; and (2) molecular volume of H_2O and D_2O for the same temperature interval.

F. LACHMAN

532.51 : 534.21

7586. Motion of a compressible fluid with varying viscosity given by $\mu = \mu_0 + \epsilon_1 x$ for positive values of x, with reference to sound waves. S. R. MUKHERJEE. *Proc. Nat. Acad. Sci. India, Sect. A*, **15** (*No.* 2–3) 91–9 (1946).

The motion of fluid, in which the variation of the coefficient of viscosity, μ, is given by $\mu = \mu_0 + \varepsilon_1 x$, for positive values of the coordinate x and is zero for all negative values of x, is discussed. Thermal processes are neglected, u, v and w are small and ε_1 is so small that its square and higher powers can be neglected. The propagation of sound waves in the medium is discussed mathematically.

J. S. G. THOMAS

532.516

7587. Studies in Newtonian flow. I. The dependence of the viscosity of liquids on temperature. A. K. DOOLITTLE. *J. Appl. Phys.*, **22**, 1031–5 (*Aug.*, 1951).

It is shown that the Walther and Andrade equations, while very satisfactory for moderate ranges of temperature, are not adequate to define the dependence of the viscosity of liquid normal paraffins on temperature over extended ranges. One method of developing a viscosity-temperature relationship is presented that gives equations defining this dependence with satisfactory validity. The purpose of this paper is to show that the precise dependence of the viscosity of liquids on temperature is complicated. This is in contrast to the relatively simple relation for the precise dependence of the viscosity of liquids on free space which will be presented in subsequent papers. A.

532.517

7588. One class of exact solutions of the equations of motion of a viscous liquid. V. I. YATSEEV. *J. Exp. Theor. Phys., USSR*, **20**, 1031–4 (*Nov.*, 1950) *In Russian.*

A general solution of the equations of motion of a viscous liquid was obtained for the case in which the velocity field is inversely proportional to the distance from a given point. An investigation is made of several particular cases of such a motion.

BROOKHAVEN GUIDE TO RUSSIAN LITERATURE

532.517.4

7589. On the law of decay of homogeneous isotropic turbulence and the theories of the equilibrium and similarity spectra. S. GOLDSTEIN. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 3) 554–74 (1951).

This paper consists of three interconnected parts. In the first, a new law of decay for homogeneous, isotropic turbulence, lately proposed by C. C. Lin [Abstr. 4563 (1949)], is derived from an extension of Kolmogoroff's theory [Abstr. 342 (1948)]; in the second, the range of validity of Kolmogoroff's theory is re-discussed, and some explicit formulae derived for the equilibrium spectrum; in the third, Lin's law of decay, and a more general law, are derived from an extension of Heisenberg's theory of the similarity spectrum [Abstr. 4525 (1949)], and some general remarks, rather in the nature of guesses—i.e. suggestions for experiment—are made on the general nature of the decay law and on the range of validity of the equilibrium spectrum. A.

532.52

7590. Statistical theory of non-homogeneous turbulence. J. ROTTA. *Z. Phys.*, **129** (*No.* 6) 547–72 (1951) *In German.*

From the Navier–Stokes ground equations, differential equations are deduced for the statistical correlation between two components of the velocity fluctuations. Relations between pressure and velocity variations are also calculated and are compared with experimental results for a particular case of parallel flow. E. H. DOCK

532.527

7591. New vorticity transfer theory. H. SASAJIMA. *Techn. Rep. Osaka Univ.*, **1** (*No.* 1–9) 21–34 (1951).

The author considers it impossible to discriminate between Taylor's vorticity transfer theory [*Proc. Roy. Soc. A*, **135**, 697–700 (1932)] and the momentum transfer theory of turbulent flow by experiments, and proposes a new vorticity transfer theory which takes account of the size of the turbulent fluid particles and the influence of the wall and viscosity. The theory gives results agreeing well with experimental results obtained by Nikuradse for turbulent flow in circular pipes [*Forsch. IngWes.*, **21**, 356 (1932)].

J. S. G. THOMAS

532.574.6

7592. Measurement of very low velocities of water-flow. R. A. BAGNOLD. Letter in *Nature, Lond.*, **167**, 1025–7 (*June* 23, 1951).

An apparatus for measuring flow velocities as low as 0·2 cm/sec is described. An opposing counter-

flow of controlled velocity, of an electrolyte having the same density as the liquid under observation, is made to emerge from a hypodermic tube pointing upstream. The controlled flow is gradually increased, and the observation of slight changes in electrical resistance near the orifice is used to indicate a balance between the two flows. The instrument is calibrated so that the required velocity can be deduced from that of the controlled flow. It can be used below the surface of a sand bed to measure water seepage. J. G. OLDROYD

532.59

7593. Propagation of tides and similar waves. J. C. SCHÖNFELD. *Delft. Technische Hogeschool Dissertation* (1951) 232 *pp.*

Fundamental mathematical methods of studying the propagation of tides in estuaries and rivers in the Netherlands were first applied by de Vries Broekman in 1916, who demonstrated the possibility of solving the differential equations of tidal motion by the calculus of finite differences. Later work was done by Lorentz, by Dronkers and by Mazure. Convinced that harmonic analysis was not suitable for the computation of the propagation of long waves, the author showed that a method used by Dietz for the computation of translation waves provided the real clue to the understanding of the propagation of long waves and associated phenomena, viz. attenuation, reflection and formation of a tail. By characteristic integration, solutions for various causal conditions can be computed directly, and the need for tentative calculations eliminated. The analysis deals with tidal motion in an estuary, dependent only upon time and one co-ordinate, x, in the direction of the length of the estuary; flow in a vertical direction, effects of banks and curves are ignored. Storm tides, waves due to manipulations of locks and weirs and waves resulting from rainfall are discussed. An abstract is given in Dutch and in French. 67 refs. J. S. G. THOMAS

532.594

7594. General linearized theory of the effect of surface films on water ripples. I. R. DORRESTEIN. *Proc. K. Ned. Akad. Wet., Ser. B,* **54,** 260–72 (*May–June*, 1951).

In calculating the damping of short surface waves due to a thin film of oil on water, account is taken of a finite surface viscosity, as well as of the known variation of surface tension with extension of the film. The absolute value of the surface tension, other things being equal, has little effect on the degree of damping. J. G. OLDROYD

CAPILLARITY 532.6

532.61.08

7595. A simple surface tensiometer. N. B. COLTHUP AND R. E. TORLEY. Note in *Analyt. Chem.*, **25,** 804–5 (*May*, 1951).

The pressure required to force bubbles of air through an orifice submerged in the liquid is measured directly as the head of the same liquid.

532.61.08 : 532.69 : 541.18

7596. Fundamental studies on interfacial tensions in flotation. V. Flow of liquids under interfacial tension. M. WADA. *Sci. Rep. Res. Inst. Tôhoku Univ. A,* **2,** 654–62 (*Aug.*, 1950).

For Pt IV, see Abstr. 6062 (1951).

532.613.4

7597. Interfacial tension at elevated pressures and temperatures. II. Interfacial properties of hydrocarbon–water systems. A. S. MICHAELS AND E. A. HAUSER. *J. Phys. Coll. Chem.*, **55,** 408–21 (*March*, 1951).

The method previously described [Abstr. 1725 (1949)] is employed to determine the interfacial tensions of the systems benzene–water and n-decane–water over the ranges 6–700 atmospheres and 20° to 130°C. L. G. CARPENTER

532.62

7598. Desorption of soluble surface layers maintained at constant area. L. SARAGA. *C.R. Acad. Sci., Paris,* **233,** 135–7 (*July* 9, 1951) *In French.*

Theoretical and experimental investigation on the desorption of a slightly soluble film (lauric acid) maintained at constant area. The methods of extrapolating the surface tension of a slightly soluble film for the time zero can be improved by the relationships obtained. The results have also been applied for improving the isotherm of lauric acid in both the condensed and gaseous state. F. LACHMAN

532.62 : 541.135

7599. The distribution of ions under a charged monolayer, and a surface equation of state for charged films. J. T. DAVIES. *Proc. Roy. Soc. A,* **208,** 224–47 (*Aug.* 22, 1951).

The potential at a charged interface between water and oil or between water and air is a function of the ionic strength of the aqueous phase. This potential has been determined in 4 different ways, which include measurements of rates of desorption of surface films and of the area occupied by "gaseous" films of long-chain detergents. Comparison of the rates of desorption of lauric acid and laurate ions shows that the Gouy equations for the electrical potential at a surface may be applied to ionized monolayers on solutions of ionic strengths as high as 2N. The Gouy equations are also verified by studying ionized films on solutions of very low ionic strength. For this purpose a very insoluble detergent, $C_{26}H_{53}N(CH_3)_3I$, has been prepared. At high ionic strengths the finite sizes of the counter-ions become important and, from the deviations from ideal behaviour, the distribution of these is deduced. Elimination of the electrical potential term from the 4 independent equations in which it occurs leads to 6 new relationships applying to ionized monolayers. One of these is the surface equation of state for charged films. A.

532.696.1

7600. Influence of liquid surface tension upon the wetting effect. C. BENEDICKS. *C.R. Acad. Sci., Paris,* **232,** 2435–7 (*June* 25, 1951) *In French.*

Experiments are cited, with 4 sets of curves, to show: (1) that the negative wetting of a solid, which diminishes its resistance to rupture, is a linear function

of the liquid surface tension; and (2) that the relative diminution of resistance to rupture by different solids is a characteristic of the solid. The liquids considered were water, ethanol, glycol, octanol, ether, benzene, toluene, xylene, petrol, tetralin, decalin, 15%, 25%, and saturated caustic soda, carbon tetrachloride, glycerine, sugar solution and castor oil. The solids were tempered steel, glass and marble. H. H. HODGSON

MOLECULAR THEORY OF LIQUIDS 532.7

532.72

7601. Experimental verification of the theory of diffusion by liquid currents in the physical solution of salts. A. CHRÉTIEN AND M. DAVION. *C.R. Acad. Sci., Paris*, **232**, 2445–7 (*June* 25, 1951).

Data are reported from experiments in which the circumstances of dissolution are reduced to the speed V of a rotating crystal with respect to the solution, for the salts KCl, NaCl, alum, gypsum and LiF. The expression, $\log K = \alpha \log V +$ const., is deduced, where K is the rate of dissolution. Analogy is thereby established between salts of varied solubility and ease of dissolution, by a dimensionless const. $\alpha = 0{\cdot}5$. The work is claimed to support the theory of diffusion by liquid currents during the physical dissolution of salts. H. H. HODGSON

532.72

7602. The dependence of the diffusion coefficient on concentration in dilute polymer solutions. L. MANDELKERN AND P. J. FLORY. Letter in *J. Chem. Phys.*, **19**, 984–5 (*July*, 1951).

An equation is deduced for the diffusion coefficient of dilute polymer solutions, showing that it is wrong to assume this coefficient to vary linearly with concentration. F. LACHMAN

532.73–2

7603. The solubility of mercury in liquid phosphorus. G. J. ROTARIU, E. SCHRAMKE, T. S. GILMAN AND J. H. HILDEBRAND. *J. Amer. Chem. Soc.*, **73**, 2527–8 (*June*, 1951).

The fact that Hg dissolves in liquid P is remarkable, as being the only known instance of a metal dissolving by a purely physical process in a non-metallic liquid. The liquid solution is perfectly clear, but upon the rapid crystallization induced by great supercooling the Hg separates in globules so numerous and fine as to give the solid a grey-black appearance resembling that of a photographic negative. The darkening is less the higher the temperature and hence the speed of crystallization. The solubility was measured by the loss in weight of Hg after equilibration with liquid P, giving 0·29 mg Hg per gram P_4; or $1{\cdot}76 \times 10^{-4}$ mole per mole or $3{\cdot}7 \times 10^{-5}$ cm³/cm³. This is $\frac{1}{5}$ the value, $5{\cdot}6 \times 10^{-4}$ cm³/cm³, calculated by the aid of regular solution theory with no allowance for the metallic nature of Hg. A.

532.782 : 536.421.4

Supercooling of liquid phosphors. *See Abstr.* 7809

MECHANICS OF GASES 533

533.15

7604. Flow of gases in porous media. L. H. WILSON, W. L. SIBBITT AND M. JAKOB. *J. Appl. Phys.*, **22**, 1027–30 (*Aug.*, 1951).

This paper presents a brief theoretical review of the viscous and free molecular flow phenomena. The equations which describe these two types of flow are applied to flow through porous media and are combined to yield a semi-empirical equation which may be used not only for the viscous and free molecular flow, but also for the transition region between these. Experimentally determined limiting values of the ratio of molecular mean free path to pore diameter are reported. These ratios may be used to indicate the nature of flow in a porous media provided the pore size is known, or they may be used to determine pore size experimentally. A.

533.15 : 536.71

7605. Transport phenomena in dense media. II. Thermal diffusion in compressed gases. W. L. ROBB AND H. G. DRICKAMER. *J. Chem. Phys.*, **19**, 818–20 (*July*, 1951).

For Pt I, see Abstr. 879 (1951). From the thermodynamics of irreversible processes, values of the thermal diffusion ratio α have been calculated using (1) the virial equation of state, (2) generalized reduced enthalpies, (3) the Lennard–Jones and Devonshire "cage" model for liquids. These results are compared with experiment and with previously published calculations for a van der Waals' gas. Only the LJD model gave results markedly superior to van der Waals' equation. The LJD model predicts very large positive values of α for compressed liquids. A.

533.15 : 545.7

7606. Diffusion apparatus for gas separation. H. KORSCHING. *Z. Naturforsch.*, **6a**, 213–17 (*April*, 1951) *In German.*

An illustrated description of a new apparatus in which the separation of a gas mixture into its components is based on the principle of diffusion against a flowing auxiliary gas, combined with mechanical transport at right angles to the flow direction of the auxiliary gas. Gives the results of measurements effected with several gas mixtures. F. LACHMAN

533.16 : 536.23

7607. A summary of viscosity and heat-conduction data for He, A, H_2, O_2, N_2, CO, CO_2, H_2O, and air. F. G. KEYES. *Trans Amer. Soc. Mech. Engrs*, **73**, 589–96 (*July*, 1951).

The available viscosity data in the literature have been collected, reduced to a uniform basis and formulated by means of an empirical equation containing three constants. At very high temperatures, the equation approaches the form of the Sutherland formula. In the case of He and A, it was not found possible to represent the data over the whole temperature range of the available measurements with a single set of constants. Attention is called to the fact that the available viscosity data are in many instances known over a sufficiently long temperature range

and with an accuracy which requires for its representation a more exact knowledge of the intermolecular field than can be obtained from the application in transport theory of a two-constant field representation. The question of the viscosity of mixtures is discussed briefly. A table of formula constants for the substances is given. A.

533.21

7608. Compressibility of gases at pressures up to 50 atmospheres. V. Carbon tetrafluoride in the temperature range 0°–400°C. VI. Sulfur hexafluoride in the temperature range 0°–250°C. K. E. MacCormack and W. G. Schneider. *J. Chem. Phys.*, **19**, 845–8 (*July*, 1951).

For Pt IV, see Abstr. 127 (1951). The gaseous compressibilities of CF_4 in the range 0–400°C, and SF_6 in the range 0–250°C, have been measured at pressures up to 50 atmospheres by a method employing gas expansion. The data have been fitted to a series equation of the type PV (Amagat units) = $A_T + B_TP + C_TP^2 + D_TP^4$, and the virial coefficients are tabulated. A.

533.5

7609. Apparatus for automatic pressure control in a high-vacuum system. M. Chiozzotto. *Nuovo Cim.*, **8**, 345–8 (*May*, 1951) *In Italian.*

533.5

7610. Vacuum valve for the handling of very pure gases. D. Alpert. Letter in *Rev. Sci. Instrum.*, **22**, 536–7 (*July*, 1951).

533.5

7611. A vacuum pre-treatment apparatus for filtering, dehydrating and degassing oil. R. G. Martin and C. N. Thompson. *Brit. J. Appl. Phys.*, **2**, 222–6 (*Aug.*, 1951).

533.5

7612. Differential methods of leak detection. J. Blears and J. H. Leck. *Brit. J. Appl. Phys.*, **2**, 227–32 (*Aug.*, 1951).

An experimental investigation of the differential method [Abstr. 1151 (1947)] of detecting leaks in high vacuum systems has shown that it is possible to attain a sensitivity 20× greater than that of the corresponding single gauge method. The differential pressure change may be produced either by differential condensation of gases such as butane or by chemical absorption of carbon dioxide. With the latter method, using extremely simple equipment, a sensitivity of 10^{-3} lμ/sec may be obtained. With differential condensation and ionization gauges the sensitivity is only a factor 10 less than that of the mass spectrometer leak detector. A.

533.6.01

7613. Aerodynamic heating at high speeds. T. R. F. Nonweiler. *J. Brit. Interplan. Soc.*, **10**, 160–76 (*July*, 1951).

Heating on a plane surface moving at heights where the boundary layer is laminar and there is no slip is considered. Mean rates of heat transfer, mean skin friction coeff. and temp. distribution in the boundary layer are calculated. The max. temp. in the boundary layer is shown to be $< 1/5$ of stagnation temp. It is suggested that the boundary layer will be laminar at all heights above 10 miles, and that the effects of slip may be neglected below 40 miles. It is shown that the heat transfer rate $\propto$ the square root of the surface pressure. A. C. CLARKE

533.6.011.3

7614. On complete forms in a turbulent three-dimensional flow of compressible viscous fluid. M. Z. Krzywoblocki. *Öst. Ingen.-Arch.*, **5** (*No.* 2) 129–37 (1951).

Prandtl has suggested a generalized tensor form for Reynolds stresses in an incompressible turbulent flow in cases where the momentum transfer theory is applied and where neither the mean nor the turbulent motions are confined to two dimensions. In the present note there is suggested a sequence of generalized tensor and vector forms for additional stresses and energy terms in a compressible viscous turbulent three-dimensional flow. Four basic equations are taken into account: equation of motion, continuity, state and energy. As the basic theory, the mixture length theory was assumed and in the equation of motion the momentum transfer theory was accepted. A.

533.6.011.5

7615. The study of a trans- or super-sonic field of [fluid] flow by means of ultrasonic waves. G. Dubois, R. Kling and E. Vieilledent. *C.R. Acad. Sci., Paris*, **233**, 129–31 (*July* 9, 1951) *In French.*

It has been previously proposed to determine the mean velocity of flow of a fast stream of gas by means of an ultrasonic beam emitted normally to the wall of the channel in which the stream flows and observing striations in the beam [Abstr. 6818 (1949)]. The possible precision of the method is limited, and determined by diffraction phenomena occurring at the boundary of the beam. On the contrary, measurements of wavelength from which it is possible to deduce the local velocity of sound, and therefrom the local temperature, increase the accuracy of determination considerably [Abstr. 93 (1950)]. A somewhat different procedure has been followed in determining the flow in a suction conduit of rectangular section. Ultrasonic waves, produced by a Hartmann siren, are emitted in the direction of the flow; the apparent wavelength at any region of the flow being determined, the corresponding Mach number is deduced and therefrom the temperature in the stream at the point in question is deduced. Application of the method is not limited by the occurrence of shock waves. Waves of length 2–3 cm can be used. J. S. G. THOMAS

533.6.011.5

7616. Air condensation in hypersonic flow. P. Wegener, S. Reed, Jr, E. Stollenwerk and G. Lundquist. *J. Appl. Phys.*, **22**, 1077–83 (*Aug.*, 1951).

The NOL 12×12 cm hyperballistics wind tunnel No. 4, which operates in a Mach number range up to 11, is briefly described. Experiments performed in this tunnel indicate that a fraction of the air condenses at or shortly after reaching the dew line for air condensation unless the supply air is preheated. The measured effects of air condensation on the flow at high Mach numbers for a variety of supply temperatures and pressures are given. It is found that of the

flow parameters commonly measured in supersonic wind tunnels, only static-pressure and shock-angle measurements are sensitive to liquefaction effects. A simple thermodynamic analysis assuming a reversible condensation process allows interpretation of some of the observations. A.

533.6.011.5 : 534.222.2

7617. On the interaction between shock waves and boundary layers. K. STEWARTSON. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 3) 545–53 (1951).

The effect on the boundary layer equations of a weak shock wave of strength ε has been investigated, and it is shown that separation occurs when $\varepsilon = O(R^{-\frac{3}{8}})$ (R = Reynolds number of boundary layer). The boundary-layer assumptions are then investigated and shown to be consistent. It is inferred that separation will occur if a shock wave meets a boundary and the above condition is satisfied. A.

533.6.011.5 : 534.24 : 534.222.2

7618. Wave reflexion near a wall. A. ROBINSON. *Proc. Camb. Phil. Soc.*, **47** (*No.* 3) 528–44 (1951).

The field of flow due to a shock wave or expansion wave undergoes a considerable modification in the neighbourhood of a rigid wall. It has been suggested that the resulting propagation of the disturbance upstream is largely due to the fact that the main flow in the boundary layer is subsonic. Simple models were produced by Howarth, and Tsien and Finston, to test this suggestion, assuming the co-existence of layers of uniform supersonic and subsonic mainstream velocities. The analysis developed in the present paper is designed to cope with any arbitrary continuous velocity profile which varies from zero at the wall to a constant supersonic velocity in the main stream. Numerical examples are calculated, and it is concluded that a simple inviscid theory is incapable of giving an adequate theoretical account of the phenomenon. The analysis includes a detailed discussion of the process of continuous wave reflection in a supersonic shear layer. A.

533.6.07

7619. Study of linear-resistance flowmeters. F. W. FLEMING AND R. C. BINDER. *Trans Amer. Soc. Mech. Engrs*, **73**, 621–4 (*July*, 1951).

A linear or linear-resistance type of flowmeter can consist of a straight piece of pipe with a porous plug, or a resistance element, and a differential gauge across the porous plug. In a certain flow range the volume rate of flow through the meter $\propto$ the pressure drop across the plug. An investigation was made of linear flowmeters with cotton and steel-wool plug elements. The tests covered a range of pipe sizes, plug lengths and plug specific weights. Typical characteristic curves are presented. A set of dimensionless ratios is proposed for a correlation of all the data for general application. A.

533.6.07

7620. Orifice meters with supercritical compressible flow. R. G. CUNNINGHAM. *Trans Amer. Soc. Mech. Engrs*, **73**, 625–38 (*July*, 1951).

The discharge characteristics of orifices at low pressure ratios were investigated. Probe measurements of high-velocity jets confirm and extend the work of Stanton. Expansion factors (Y) at pressure ratios down to $r = 0{\cdot}13$ were measured for the flow of air in a 2 in pipe meter and for the flow of steam in a 3 in pipe meter. A linear Y-r correlation is shown to exist at low pressure ratios; a change of flow regime occurs at a pressure ratio of $0{\cdot}63$. A theoretical solution for supercritical flow, previously established by the author, is further compared with experimental results. A.

MOLECULAR THEORY OF GASES 533.7

533.72

7621. On the radial distribution function of an imperfect gas and the superposition principle. B. R. A. NIJBOER AND L. VAN HOVE. *Proc. K. Ned. Akad. Wet., Ser. B*, **54**, 256–9 (*May–June*, 1951).

The term proportional to the square of the density in the expansion of the radial distribution function of an imperfect gas in powers of the density is calculated exactly in the case of a gas consisting of hard spheres. The result can be checked by means of the value of the 4th virial coefficient, which has been known for a long time for such a gas. The exact expression, being a function of the distance r between two molecules, is compared with the approximate one, obtained by applying the superposition principle introduced by Kirkwood. A.

533.75

7622. The interpretation of intermolecular force parameters. S. D. HAMANN. Letter in *J. Chem. Phys.*, **19**, 655 (*May*, 1951).

A comparison is made of the equilibrium intermolecular separations derived from virial coefficient data and the calculated lengths of nearly ellipsoidal non-polar molecules which supports the views of Bird, Spotz and Hirschfelder [Abstr. 899 (1951)]. The maximum interaction energies for various gases are then calculated from molecular parameters independent of gas behaviour, with remarkable agreement with experiment. R. H. DAVIES

533.75 : 536.422.15

7623. An attempt to interpret the solution of a solid in a compressed gas. S. ROBIN, B. VODAR AND R. BERGEON. *C.R. Acad. Sci., Paris*, **232**, 2189–91 (*June* 11, 1951) *In French.*

Poynting's equation for the variation of vapour pressure of a substance with external pressure produced by a second gas is examined. Owing to interactions between the gas molecules the simple equation does not represent exactly the experimental results in all cases. Using the results from statistical mechanics an expression for the vapour pressure involving the interactions is deduced which by the use of Lennard–Jones interaction potential enables collision diameters and interactions between different molecules to be calculated. The results are applied to phenanthrene in N_2. F. E. HOARE

VIBRATIONS . ACOUSTICS 534

534.014 : 518.4

7624. A graphical method for solving vibration problems of a single degree of freedom. V. G. BRUCE. *Bull. Seism. Soc. Amer.*, **41**, 101–9 (*April*, 1951).

In soln. of equations of type $\ddot{y} + p^2y = 0$, the soln. in the phase plane (where co-ords. are y and $\dot{y}/p$) is a circle. If p^2y is replaced by a non-linear function, say $f(y)$, an approx. soln. in the form of a series of circular arcs may be obtained by replacing $f(y)$ by a series of chords. If $f(y)$ becomes negative, the soln. becomes a series of hyperbolic arcs. By using this approximation the time of swing of a simple pendulum with initial amplitude 2·2 radians is found to agree within 1 part in 400 with the exact answer. This method is suitable for numerical computation in many cases where an analytical treatment is impossible.

N. CORCORAN

534.134

7625. Frequency stabilization. M. FOUCHÉ. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **16**, 33–50 (*Jan.*, 1951) *In French.*

Reference is made to Melde's experiment in which a tuning fork and a cord form a coupled vibrating system, emphasis being placed on the fact that from the standpoint of frequency and of maintenance of the vibrations the whole system (fork and cord) and not only the fork must be considered. A discussion follows on the Bouasse–Sarda regulator where the speed of a motor is controlled by the vibrations of the cord. Experiments are described to determine whether or not the frequency control is an "absorption regulator." In conclusion, the author discusses (*a*) the Weber phenomenon, involving the interaction of two oscillators, and (*b*) the vibrations of the wings of an aeroplane (a double oscillator—torsion and flexural).

A. B. WOOD

534.154 : 621.317.39

7626. A new vibration measuring apparatus and its uses. M. WEBER. *Schweiz. Arch. angew. Wiss. Tech.*, **17**, 129–39 (*May*, 1951) *In German.*

The mathematical design of vibration recording apparatus is given briefly with special reference to the measurement of shock waves and periodic oscillations. Details are given of a piezoelectric accelerometer, which, with its associated preamplifier and batteries is contained within a waterproof housing $8\frac{1}{2}$ cm dia. by $3\frac{1}{2}$ cm high. The natural frequency of the equipment is 3 500 c/s, and its output is linear up to 400 c/s. A velocity pick-up is also described consisting of a mass supported by springs and constrained to move in one direction only. The motion of the mass is converted into electrical energy by an electromagnetic system. The amplifiers and recording apparatus are also described, time markers being provided from an impulse generator.

A. C. WHIFFIN (R)

534.2 : 389.6 : 621.395.625

7627. Standards on electroacoustics: definitions of terms, 1951. *Proc. Inst. Radio Engrs*, **39**, 509–32 (*May*, 1951).

534.21

7628. Propagation of sound waves in heterogeneous material. H. WEIBULL. *IVA, Stockholm*, **22** (*No.* 2) 58–62 (1951).

The material may be treated as comprising two phases, solid and gaseous or alternatively as one system where the gaseous phase occurs as bubbles in the solid system. A review is given of methods used to treat the problem theoretically and to obtain propagation constants by measurement and calculation.

G. F. HODSMAN

534.21

7629. On the intensity distribution of the ultrasonic field in liquids. E. GROSSETTI. *Nuovo Cim.*, **8**, 301–7 (*May*, 1951) *In Italian.*

Deals with the experimental determination of the intensity distribution of an ultrasonic beam ($\nu = 1{\cdot}8$ Mc/s) perpendicularly to the propagation direction in water, in colloidal solutions of Ag and S, and in liquid mixtures. Accounting for the variation of λ for the liquids employed, the ultrasonic beam remains unaltered in colloidal solutions, but broadens in liquid mixtures. This may be interpreted as a consequence of a diffusion of ultrasonic waves in these liquids. Further experiments at higher frequencies may confirm these results.

A.

534.21

7630. Cavitation and haemolysis by ultrasonics of different frequencies. A. DOGNON AND Y. SIMONOT. *C.R. Acad. Sci., Paris*, **232**, 2011–12 (*May* 28, 1951) *In French.*

At low frequencies (19 kc/s), cavitation of vapour with a high threshold is obtained; at high frequencies (500 to 1 200 kc/s), a gaseous cavitation with a low threshold is obtained. The influence of experimental conditions, particularly intensity and dilution, is stressed.

G. F. HODSMAN

534.21 : 539.132

7631. Ultrasonic absorption in carbon disulphide. J. LAMB AND J. H. ANDREAE. Letter in *Nature, Lond.*, **167**, 898–9 (*June* 2, 1951).

Results obtained for ultrasonic absorption in CS_2 in the frequency range 30–195 Mc/s support the assumption of a relaxation of the transfer of energy to the degenerate bending vibration of the molecule.

W. R. ANGUS

534.21 : 591.81

7632. Resonances of biological cells at audible frequencies. E. ACKERMAN. *Bull. Math. Biophys.*, **13**, 93–106 (*June*, 1951).

Two theories are discussed to account for the observed resonances of biological cells at sonic frequencies. One theory assumes the cell wall to be a stretched balloon surrounded by, and filled with, an incompressible fluid. The other treats the cell wall as a rigid shell. Both lead to reasonable physical constants for the cell wall.

A.

534.21 : 771.535

7633. A note on the activation of photographic emulsions by ultrasonic waves. G. S. BENNETT. *J. Acoust. Soc. Amer.*, **23**, 478–80 (*July*, 1951).

Diffraction patterns have been obtained on photo-

graphic plates placed normal to ultrasonic beams produced by a 1 in dia. $BaTiO_3$ disk operating at 1 073 kc/s. Typical diffraction pattern results are given and the mechanism of the production of the latent image is briefly considered. G. F. HODSMAN

534.213.4

7634. Wall viscosity and heat conduction losses in rigid tubes. R. F. LAMBERT. Letter in *J. Acoust. Soc. Amer.*, **23**, 480 (*July*, 1951).

A theoretical analysis of wall viscosity and heat conduction losses to determine the attenuation of the higher-order modes of acoustic tubes. Reference is made to Slater's analysis of the energy relations for electromagnetic wave-propagation analogous to the acoustic case. A. B. WOOD

534.221

7635. Ultrasonic velocity in organic solutions. II. K. C. LAL. *Indian J. Phys.*, **25**, 73–8 (*Feb.*, 1951).

For Pt I, see Abstr. 3409 (1951). Reports the ultrasonic velocities and adiabatic compressibilities of solutions of benzoic acid in absolute alcohol, isobutyl alcohol and carbon tetrachloride at various temperatures. A.

534.23 : 538.245

7636. The influence of magnetization on ultrasonic attenuation in a single crystal of nickel or iron-silicon. S. LEVY AND R. TRUELL. Letter in *Phys. Rev.*, **83**, 668 (*Aug.* 1, 1951).

With a single crystal of Ni measurements of the attenuation of ultrasonic waves in the range 5–50 Mc/s were made with a magnetic field applied perpendicularly to the ultrasonic beam which was at 12° to the 111 direction. Increase of the magnetic field from zero to saturation decreased the attenuation to a ninth at 50 Mc/s. At saturation the attenuation was independent of frequency, while, at other field strengths, it increased with frequency. Similar but smaller effects occurred with Fe–Si single crystals. With Ni, no change of ultrasonic velocity occurred. Similar changes of attenuation occurred with Ni when the applied field was directed along the axis of the ultrasonic beam. It is suggested that the changes result from a change in the scattering of the ultrasonic radiation by the lattice which is affected by the magnetic domain orientations and hence by the applied field. A. C. WHIFFIN

534.23 : 578.088.2

7637. A bibliography on sonic and ultrasonic vibration: biological, biochemical and biophysical applications. G. M. NAIMARK, J. KLAIR AND W. A. MOSHER. *J. Franklin Inst.*, **251**, 279–99 (*Feb.*); 402–8 (*March*, 1951).

Contains 580 entries gathered from journals of abstracts in the period 1900–50. Arranged chronologically, with author and subject indices.

534.23

7638. Molecular motion in fluids and internal dispersion and absorption of elastic and optical waves. A. K. DUTTA. *Sci. and Cult.*, **16**, 576–9 (*June*, 1951).

Elastic waves have been treated on the same lines as optical waves, on the basis of molecular motion. Starting with the relation, $d\rho/\rho = Kdp/p$, where $K = p/\rho\sqrt{2}$ is the di-elastic constant, corresponding to the dielectric constant in the optical case, and taking the equation of motion for an ideal fluid, with due considerations for the forces of friction and restitution, relations have been obtained for the polarization pressure P and the dielastic constant K. They come out in the form $P = NmR(\gamma - 1)(1 + \alpha)\omega^2\xi$ and $K = 1 - R(1 + \alpha)(\gamma - 1)[(1 + \alpha)\{1 + R(\gamma - 1)\} - f - ig\omega]^{-1}$ where, N = number of molecules per cm^2, m = mass of molecule, γ = ratio of sp. heats in any gaseous state, R = ratio of densities of the state under consideration to the gaseous state with the particular value of γ, α = excitation constant, ω = wave frequency $\times 2\pi$, ξ = displacement due to pressure variation, f and g = coefficients of restitution and friction, acting on a molecule. The relations explain all the characteristics of supersonic absorption and also an internal dispersion, indicated by the author. The effect of molecular motion on optical waves has also been stressed. AUTHOR

534.23 : 551.575

7639. On the subject of the absorption of sound in mists. Y. ROCARD. *Rev. Sci., Paris*, **89**, 42–3 (*Jan.–March*, 1951) *In French.*

It is suggested that drops of water in suspension in the air can be set in vibration by the sound wave and therefore contribute to absorption. In particular, the small droplets present in mists would absorb the higher frequencies and so explain the selective absorption experienced under these conditions. A simple calculation showing the order of magnitudes is given. G. F. HODSMAN

534.232

7640. Quartz ultrasonic generator of high output. H. H. RUST. Letter in *Naturwissenschaften*, **38** (*No.* 10) 235–6 (1951) *In German.*

The life of the usual quartz generator having thin metallic electrodes is limited at high outputs by cavitation of the electrodes. This can be overcome by using a fine wire grid electrode supported in a simple holder, which is described. H. J. H. STARKS

534.232 : 621.395.62

7641. The construction of efficient ultrasonic radiators. II. E. SKUDRZYK. *Elektrotech. u. Maschinenb.* [*EuM*] **68**, 202–12 (*April*, 1951) *In German.*

The idea of mechanical impedance is introduced and expressions given for equivalent mass and stiffness. Losses in the quartz are represented by a simple resistance. An example is given of the calculation of the equivalent circuit and radiated power of a crystal. An introduction is given to the more accurate theory of quartz resonators and in particular it is shown how the simple equivalent circuit must be modified to take this into account. The magnetostrictive oscillator is treated in a similar way to the quartz and numerical examples given. Finally the problem of measuring the radiated power is studied. These include: direct measurement of the radiation pressure, heating effect in an oil-bath, and in the case of quartz radiators, the measurement of the voltage across the resonator. S. C. DUNN (R)

534.232 : 621.395.62 : 621.317.7

7642. A simple type of $X(t) - Y$ recorder. T. A. PERLS AND W. A. WILDHACK. Letter in *Rev. Sci. Instrum.*, **22**, 541–2 (*July*, 1951).

534.24 : 534.222.2 : 533.6.011.5

Wave reflexion near a wall. *See Abstr.* 7618

534.415

7643. Note on stroboscopes and musical strobographs. V. GAVREAU. *Ann. Télécommun.*, **6**, 117–21 (*May*, 1951) *In French.*

A stroboscope is described with an endless band which gives representation of any frequencies. A second portable type with a drum, and a musical strobograph are also described. The use of these instruments for studying the tuning of musical instruments and in problems of musical audition is mentioned. G. F. HODSMAN

534.613

7644. Acoustic radiation pressure. J. MERCIER. *C.R. Acad. Sci., Paris*, **232**, 2181–3 (*June* 11, 1951) *In French.*

The limitations of the usual calculation are indicated and an alternative method of approach is suggested. G. F. HODSMAN

534.78

7645. The interconversion of audible and visible patterns as a basis for research in the perception of speech. F. S. COOPER, A. M. LIBERMAN AND J. M. BORST. *Proc. Acad. Nat. Sci., Wash.*, **37**, 318–25 (*May*, 1951).

A pattern playback is described which reconverts spectrograms into sound, either in their original form of after modification. It may be used either with film transparencies or with spectrograms drawn with white paint on a transparent plastic base. Tests are also described, on the sounds produced when patterns familiar to the eye, such as simple geometrical figures, are transformed by the apparatus. G. F. HODSMAN

534.793

7646. The objective measurement of loudness, particularly of machinery noise. W. HOLLE. *Funk u. Ton*, **5**, 239–47 (*May*, 1951) *In German.*

The author discusses the objective loudness meter known as the "DIN" as recommended by the American Standards Institution and the British Standards Institution. He then refers to the work of Steudel and of Bürck–Kotowski–Lichte [*E.N.T.*, **12**, 326–33 (*Oct.*, 1935); *E.N.T.*, **13**, 1–12 (*Jan.*, 1936)] dealing with the equivalent circuit of the ear. The results obtained by these workers are applied to the design of a small portable loudness meter. Curves are shown illustrating the response of this meter (phon db) in terms of impulse duration, etc. A. B. WOOD

534.846

7647. Acoustics and sound exclusion. W. A. ALLEN AND P. H. PARKIN. *Archit. Rev.*, 377–84 (*June*, 1951).

An account of the acoustical treatment of the Royal Festival Hall, London, including the surrounding foyers and staircases, roof, etc. The design of the hall and provision of absorbents embodies the result of much recent research, and provision has been made for further experimental adjustments in the light of experience in use.

534.851 : 621.395.625.2 : 681.84

7648. Gramophone turntable speeds. G. F. DUTTON. *Wireless World*, **57**, 227–32 (*June*, 1951).

Relationship between parameters such as playing time, turntable speed, record diameter, minimum groove speed and harmonic distortion are discussed and illustrated by numerous curves. It is shown that 12 in records can be played both at $33\frac{1}{3}$ and 45 r.p.m. with good quality up to 18 min, 10 in records to about 14 min and 7 in records up to 5 min at 45 r.p.m., and that with decreasing record diameter distortion drops rapidly with increasing turntable speed. A. LANDMAN

OPTICS . RADIATION . SPECTRA 535

535.214.6

7649. On photophoresis, the true magnetic charge, and the helical motion of matter in [various] fields. I. F. EHRENHAFT. *Acta Phys. Austriaca*, **4** (*No.* 4) 461–88 (1951) *In German.*

Reviews some of the experimental results to date on the movement of small particles under the influence of some or all of the following fields: gravitational, electric, magnetic, and electromagnetic. Reasons are given in support of the proposition that certain orbits can only be accounted for by supposing that the particle carries a single magnetic pole. N. CORCORAN

535.23

7650. An absolute method of measuring the black-body temperature. K. S. VULFSON. *J. Exp. Theor. Phys., USSR*, **21**, 507–9 (*April*, 1951) *In Russian.*

The new method is based on the comparison of the intensities of the spectral radiation at various wavelengths for two different temperatures. The laws of the black-body radiation enable, if the spectral intervals are sufficiently far from each other, both temperatures to be determined unequivocally. Two special advantages of the method are that neither the spectral transparency of the monochromator nor the spectral sensitivity of the receiving apparatus need be known, and that no radiation etalon of known spectral distribution is required. The theory is given for one of the waves lying in the range of validity of Wien's (approximate) law, the other in the long-wave part of the spectrum where the Rayleigh–Jeans approximation holds. The most general case is then considered on Planck's formula. The method cannot claim a particular accuracy, but its value resides in its suitability as check on other methods, and for the gradation of optical pyrometers. It is furthermore suitable for measuring the temperatures of grey and selective radiators, the spectral emissivity of which is independent of the temperature. B. F. KRAUS

535.23.08

7651. Glass film bolometers. K. M. LAING AND J. V. FITZGERALD. Letter in *Rev. Sci. Instrum.*, **22**, 540–1 (*July*, 1951).

A piece of very thin soda-lime-silica plate or window glass is cemented to a wire ring and colloidal graphite electrodes painted on both sides. 10^{-3} cm dia. Al connecting wires are embedded in the wet electrodes. When radiant energy falls on the glass its electrical conductivity C varies as $C_0 \exp(-H/RT)$, where

H, the activation energy, is 16–22 kcal/mole depending on the annealing of the glass. A photograph of the bolometer is included. The bolometer is stated to compare favourably with the thermistor flake type. See Abstr. 2423 (1950). S. WEINTROUB

535.231.2

7652. Conditions for blackbody radiation by solids and gases. W. FINKELNBURG. *Overseas Res. Rep.* (*Dep. Sci. Industr. Res. Lond.*) 186/51 [*Off. Tech. Serv. Wash.*, *PB* 99427].

A formula is derived for the spectral distribution of the radiant energy emitted per cm² of any thermal radiation source (emissive power) as a function of its absorption coefficient $a(\lambda, T)$, its absolute temperature T, and the thickness of its radiating layer d. The atomistic meaning of the absorption coefficient $a(\lambda, T)$ is discussed. The formula shows that the emissive power of any radiator approaches that of the blackbody of the same temperature, if the product $a(\lambda, T)d$ approaches infinity. Conclusions from the formula are drawn for the emission of incandescent metals, incandescent selective radiators like the Nernst glower or similar heated solids, and for incandescent gases or vapours. From these last radiation sources the surprising result is that the spectral energy distribution of any incandescent gas or vapour approaches that of the blackbody of the same temperature for a sufficiently thick radiating layer. The continuous spectrum of the sun is discussed in this connection. Technical conclusions are drawn from these theoretical considerations with respect to radiation sources in general, and especially with respect to high-pressure Hg arc, the Cs arc, and the high-current C arc.

535.234

7653. A note on Planck's radiation formula. W. KOFINK. Letter in *Naturwissenschaften*, **38** (*No.* 10) 234 (1951) *In German.*

In the black-body radiation formula, the fraction of energy on the short-wave side of λ_{max} is known to be about $\frac{1}{4}$. In this note the integral is evaluated as 0·2500545468. P. M. DAVIDSON

535.241.42

7654. Variation in the horizontal distribution of light from candlepower standards. W. E. K. MIDDLETON AND E. G. MAYO. *J. Opt. Soc. Amer.*, **41**, 513–16 (*Aug.*, 1951).

A recording goniophotometer was used to measure the luminous intensity around the horizontal plane for several types of lamps used as working standards of candlepower. It was found that variations in the intensity of the light in a few degrees of arc could sometimes lead to an error much greater than the supposed error in the calibration of such lamps. Of those tested it was found that the lamps most suitable for use as working standards of candlepower have relatively large spherical or conical bulbs and well-supported filaments. A.

535.242.2 : 621.397

7655. Contrast measurement in TV images. A. E. MARTIN, R. Q. VOGEL AND F. W. HARJES. *Radio Electronic Engng*, **45**, 3–5, 27 (*June*, 1951).

Methods of measuring large area contrast of television picture tubes are discussed. Direct photometric measurements by means of an illuminometer are preferable on account of speed and accuracy to photographic and densitometric methods. A modified Macbeth illuminometer is described, which is essentially a portable photometer with a Lummer–Brodhun cube and an enclosed standard lamp movable towards the cube by a calibrated rack and pinion drive. By the use of blue photometric filters accurate colour match is possible, the standard colour temperature being 2 360°K. Calibration and application of the instrument are described, and some typical contrast determinations are tabulated. A. LANDMAN (R)

535.243

7656. Photoelectric spectroradiometry and its application to the measurement of fluorescent lamps. R. STAIR. *J. Res. Nat. Bur. Stand.*, **46**, 437–45 (*June*, 1951).

This paper describes new equipment and its applications in the precise determination of the spectral radiant energy emission of light sources having low intrinsic brightness, in particular fluorescent lamps. The evaluation of the spectral radiant energy distribution of light sources having superimposed bright lines is discussed in detail. Data are given on a number of commercially available fluorescent sources. Applications are noted in other problems, for example absolute spectral emissivity measurements on tungsten, spectral reflectivities, spectral transmittance measurements on dark shade welding glass, total ozone studies, or measurements in other situations where low intensities may be involved. A.

535.313

7657. Five-inch molded silver chloride correctors for a Kellner–Schmidt system. J. C. EVANS AND T. A. KING. *J. Opt. Soc. Amer.*, **41**, 510–12 (*Aug.*, 1951).

AgCl corrector plates of 5 in dia. for a Kellner–Schmidt optical system of f: 82 relative aperture designed for 3μ-radiation have been moulded by both confined and unconfined flow pressing between stainless steel dies. Measurements of the die contours, corrector plate contours, and transverse aberration of the system have been made for each of these procedures. With mould correction, largely to compensate for elastic recovery of AgCl, Schmidt corrector plates can readily be produced of optical quality sufficient for many applications. A.

535.313.2

7658. The determination of a three-mirror system consisting of an (arbitrary) paraboloidal mirror and a two-mirror supplementary system, for which spherical aberration is removed and the sine condition (freedom from coma) is strictly fulfilled. Investigation into the substitution of the (deformed) auxiliary mirror by more simply produced mirror surfaces. I–IV. J. PICHT. *Optik*, **8** (*No.* 3) 129–44; (*No.* 4) 145–61; (*No.* 5) 193–205; (*No.* 6) 241–50 (1951) *In German.*

The surfaces of the two supplementary mirrors, which are in general aspherical, are found in the form of differential equations suitable for computation. A numerical example is given, and the surfaces are replaced by the nearest spherical surfaces. Trigonometrical calculations confirm the state of correction of the system. R. W. FISH

535.317.4 : 535.8

7659. The diffraction theory of aberrations. E. Wolf. *Rep. Phys. Soc. Progr. Phys.*, **14**, 95–120 (1951)

A historical and critical survey of investigations into image formation in optical instruments. The advances of recent years, which are discussed, include the effects of small aberrations, tolerance criteria, and the asymptotic treatment of diffraction problems. A section is included on investigations into the effects of waves of non-uniform amplitude. The detailed light distribution in typical images is illustrated by isophote-diagrams and photographs. A.

535.325

7660. An optical method for following mixing processes. J. F. Kaan and J. B. Westerdijk. *Ingenieur*, **63**, *O*33–*O*35 (*June* 29, 1951) *In Dutch.*

An apparatus is described which indicates the increasing homogeneity of a mixture of fluids or gases during the mixing process. The optical method is very sensitive and allows the operator to observe even very small fluctuations of the concentration. A.

535.33.07 : 535.825

7661. Some aspects of microspectrography. M. H. F. Wilkins. *Disc. Faraday Soc., No.* 9, 363–9 (1950).

Simple theory is given for errors in microspectrography due to (i) use of very small objects, (ii) refractile and non-refractile objects being slightly out of focus, (iii) aberrations in the microscope objective. Dichroism of nucleic acid is also discussed. A.

535.33.07 : 535.825

7662. Aspects of ultra-violet and infra-red microspectrography with the Burch reflecting microscope. R. Barer. *Disc. Faraday Soc., No.* 9, 369–78 (1950).

Some of the difficulties encountered in microspectrography with reflecting microscopes are discussed. The development of objectives achromatic over all the regions of the spectrum enables the technique to be greatly simplified. The object is illuminated by the total radiation emitted by the source and the transmitted radiation is analysed by means of a suitable spectrometer. In the u.v. region photographic recording enables the absorption characteristics of the object to be observed simultaneously at a large number of wavelengths. Present i.r. techniques do not allow simultaneous recording, but nevertheless continuous sources of radiation can be used. This feature permits the position of absorption maxima and the presence of spectral fine structure to be determined with accuracy. These techniques can be used with polarized radiation for work on dichroism of oriented structures. The types of problem for which such methods are particularly suitable are indicated. Infra-red microspectrophotometry is limited chiefly by the long wavelengths employed, resulting in low resolution in the microscope, and by the relative insensitivity of present thermal detectors. It is rather doubtful whether the method can ever be applied to living cells. Even with dry cells the present indications are that the differences in i.r. absorption spectra obtained from such complex mixtures of proteins and other substances as occur in biological material are very slight. Technical improvements will be necessary before really useful information can be obtained from such material. A.

535.33.07 : 535.825

7663. Studies with a reflecting microscope: microspectroscopy of living and fixed cells. R. C. Mellors. *Disc. Faraday Soc., No.* 9, 398–406 (1950).

The reflecting microscope is used with a spectrograph to record the ultra-violet absorption and fluorescence emission in cellular areas of 1 μ^2 or less, and to detect in cervical smears optical differences between normal cells and cells which have abnormal features suggestive of but not conclusive for cancer. A method of secondary fluorescence microphotometry developed for the scanning of cells of a smear and the detection of cellular abnormalities relates the fluorescence intensity and the chromatin content of the nucleus. A.

535.33.07 : 535.825

7664. Self-recording microspectrography and its applications on problems regarding the endocellular formation of haemoglobin. B. Thorell. *Disc. Faraday Soc., No.* 9, 432–6 (1950).

For studying the endocellular haemoglobin synthesis a single-beam recording microspectrograph, working in the short wavelength visible range, is described. A.

535.33.07–14 : 621.396.615.17

7665. Synchronizer for 100-kc square wave generator. L. C. Hedrick. Letter in *Rev. Sci. Instrum.*, **22**, 537 (*July*, 1951).

See Abstr. 815 B (1950); *Rev. Sci. Instrum.*, **20**, 781–3 (*Nov.*, 1949).

535.33.07–15 : 535.825

7666. Infra-red microspectrometry with a 0·8 N.A. reflecting microscope. R. D. B. Fraser. *Disc. Faraday Soc., No.* 9, 378–83 (1950).

The numerical aperture (N.A.) of a reflecting objective employed with an i.r. spectrometer determines the minimum size of sample from which spectra may be obtained. High numerical apertures are important both to increase the energy collected from a given sample and to reduce the size of the diffraction pattern of its image. A 0·8 N.A. reflecting objective used in conjunction with a Grubb–Parsons spectrometer is described. Optical refinements have been introduced which (i) ensure the efficient transfer of energy from microscope to spectrometer, and (ii) facilitate the alignment and focusing of the magnified image of the sample in the plane of the slit. Details of the size of the microfocus at various wavelengths, and examples of the spectral resolution of which the instrument is capable, are given. A.

535.33.07–15 : 535.825

7667. Infrared microspectroscopy. II. E. R. Blout and G. R. Bird. *J. Opt. Soc. Amer.*, **41**, 547–51 (*Aug.*, 1591).

For Pt I, see Abstr. 6375 (1950). An improved i.r. microspectrometer is described. A figure of performance or merit for i.r. spectrometers using certain types of specimens is suggested. An experimental value is given for this performance figure for the instrument now in use in our laboratory. The increased performance of the microspectrometer may be observed in the spectral data shown for typical specimens. Spectral resolving power and sample size requirements for i.r. microspectroscopy are considered

for typical organic chemical substances. It now appears that for many applications the limiting factor on sample size is the difficulty in the preparation and handling of the sample rather than the performance of the instrument. A.

535.33.07–32

7668. Recent advances in ultra-violet absorption spectroscopy. W. C. PRICE. *Rep. Phys. Soc. Progr. Phys.*, **14**, 1–18 (1951).

Recent progress in the design and construction of photoelectric spectrophotometers is reviewed. Their associated equipment, such as low-voltage hydrogen lamps, ultra-violet sensitive photocells, etc., is discussed. Double-beam recording spectrophotometers and methods of cathode-ray presentation of spectra are described and an account is given of the methods of ultra-violet microspectrophotometry. Developments in the vacuum ultra-violet, solar spectroscopy, high-intensity light sources, photographic emulsions, etc., are discussed and progress in the interpretation of ultra-violet absorption spectra is reviewed. A.

535.331 : 535.338

7669. The spectrum of doubly ionised tantalum. I. FERNANDO AND S. G. KRISHNAMURTY. *Curr. Sci.*, **20**, 125–6 (*May*, 1951).

A brief discussion of some term intervals deduced from a study of highly condensed sparks between Ta electrodes. J. D. CRAGGS

535.331 : 537.228.5

7670. On the relative intensity of first-order Stark components. S.-M. KUNG. Letter in *Phys. Rev.*, **83**, 665 (*Aug.* 1, 1951).

Numerical errors in previous treatments are pointed out. L. PINCHERLE

535.338 : 536.46

7671. Predissociation in the spectrum of OH; the vibrational and rotational intensity distribution in flames. A. G. GAYDON AND H. G. WOLFHARD. *Proc. Roy. Soc. A*, **208**, 63–75 (*Aug.* 7, 1951).

In the main 3 064 Å system of OH higher rotational levels of bands with $v' = 1$ and all levels with $v' \geqslant 2$ are affected by a weak predissociation. One spin component of the $^2\Sigma^+$ levels is more strongly affected than the other. Of the three molecular states, $^4\Pi$, $^4\Sigma^-$ and $^2\Sigma^-$, which could conceivably cause the predissociation, only the $^2\Sigma^-$ could produce this effect. The predissociation is observed in the OH bands from a discharge and from the reaction zone of an oxy-acetylene flame at low pressure, and also to some extent in a flame at atmospheric pressure. The predissociation, and its reverse process, a "pre-association," may also affect the vibrational intensity distribution if there is departure from equilibrium. Striking anomalies of this type in H flames are interpreted in this way. For flames at 1 atm. pressure there appears to be an excess of free atoms in the flame, and at low pressure emission of radiation from the flame disturbs the equilibrium. A.

535.338 : 539.132/.133

7672. Perturbations in band-spectra. A. BUDÓ AND I. KOVÁCS. *Acta Phys. Hungarica*, **1** (*No.* 1) 84–96 (1951) *In German.*

Theoretical expressions for the perturbing matrix elements and for the energies are developed from a consideration of spin-orbit interaction for $^3\Pi$–$^1\Pi$, $^3\Pi$–$^1\Sigma$, $^2\Pi$–$^2\Pi$ and $^3\Pi$–$^3\Pi$ perturbations.

R. F. BARROW

535.338 : 539.132/.133

7673. The evaluation of the rotational constants for diatomic molecular levels from perturbation data. II. I. KOVÁCS. *Acta Phys. Hungarica*, **1** (*No.* 1) 97–103 (1951) *In German.*

For Pt I, see Kovács, *Z. Phys.*, **106**, 431 (1937). Explicit expressions are given from which the rotational constants of perturbing states for the cases of a singlet transition perturbed by a singlet or a triplet state. The method depends on the observation of at least two "extra" lines at the perturbation.

R. F. BARROW

535.338.1 : 535.331

7674. Excitation of some new permitted and forbidden lines of Al I in the ultraviolet. S. WENIGER AND R. HERMAN. *C.R. Acad. Sci., Paris*, **232**, 2300–2 (*June* 18, 1951) *In French.*

Measurements are given of Al I lines in the region 2 094–3 035 Å excited in an arc at 4–50 A in an atmosphere of N_2 at 1–80 kg/cm^2. R. F. BARROW

535.338.3 : 539.153 : 523.77

7675. Atomic spectra for the astrophysicist. C. E. MOORE. *Science*, **113**, 669–73 (*June* 15, 1951).

A survey of the available published data on atomic energy levels, ultraviolet multiplets and the solar spectrum, with suggestions as to the more urgent needs of astrophysicists for further lab. data on atomic spectra. D. L. EDWARDS

535.338.332

7676. Report on the new discoveries in the hydrogen spectrum. W. THIRRING. *Acta Phys. Austriaca*, **4** (*No.* 4) 325–37 (1951).

535.338.332

7677. Nuclear effects in atomic spectra. E. W. FOSTER. *Rep. Phys. Soc. Progr. Phys.*, **14**, 288–315 (1951).

Optical investigations of hyperfine structure, especially isotope structure, are reviewed. Recent work on the nuclear mass effect in He is described. Isotope shifts in heavy element spectra are discussed and the theory of the effect of finite distribution of nuclear charge is outlined. A brief description of some magnetic hyperfine structure investigations is given. A.

535.338.332

7678. On the isotope shift in the Gd I spectrum. P. BRIX AND H. D. ENGLER. Letter in *Naturwissenschaften*, **38** (*No.* 9) 214 (1951) *In German.*

The hyperfine structure of Gd I supports the view that the abnormally high isotope shift in Eu arises from the nucleus, not from the 4*f* electrons.

S. T. HENDERSON

535.338.332

7679. On the hyperfine structure of hydrogen and deuterium. F. E. LOW AND E. E. SALPETER. Letter in *Phys. Rev.*, **83**, 478 (*July* 15, 1951).

Improved data on proton-neutron forces have made more accurate the result of a previous calculation [Abstr. 3933 (1950)]. Agreement with experiment is

poor and it is concluded that this is a result of the structure of the nucleons themselves, e.g. the magnetic moment of a nucleon must spread over a finite radius.

L. PINCHERLE

535.338.332

7680. The fine structure of the α-line of heavy hydrogen. G. W. SERIES. *Proc. Roy. Soc. A*, **208**, 277–84 (*Aug.* 22, 1951).

In continuation of work reported earlier [Abstr. 6357 (1950)], the weak satellite $2P_{\frac{3}{2}}$–$3S_{\frac{1}{2}}$ in the α-line 6 561 Å of the Balmer series of heavy H has been resolved. The light was produced as before in a U-tube cooled by liquid H, and analysed by a double Fabry–Perot interferometer with spacings in the ratio 1 : 2. The satellite was found to be at a distance $0{\cdot}1326 \pm 0{\cdot}001$ cm^{-1} from the neighbouring strong component $2P_{\frac{3}{2}}$–$3D_{\frac{5}{2}}$, in disagreement with the distance $0{\cdot}1409$ cm^{-1} predicted by the Dirac relativistic theory of the H atom. The difference $0{\cdot}0083 + 0{\cdot}002 - 0{\cdot}003$ cm^{-1} (where the limits also include possible errors in certain corrections) is interpreted as an upward shift of the 3*S* term, and is compared with the value $0{\cdot}0104$ cm^{-1} predicted by the radiation theory of Bethe and others [see, for example, Abstr. 3927 (1950)]. A.

535.338.332

7681. Hyperfine structure in the $5d^9 6p$ and $5d^8 6s^2$ configurations of the spectrum of Hg III. E. W. FOSTER. *Proc. Roy. Soc. A*, **208**, 367–91 (*Sept.* 7, 1951).

In most of the lines $5d^9\,6p$–$5d^8\,6s^2$ the components due to Hg^{200}, Hg^{202} and Hg^{204} have been resolved and term isotope shifts have been assigned for these isotopes for nearly all the terms of each configuration. Some less accurate data for Hg^{198}, Hg^{199} and Hg^{201} are obtained from measurements on incompletely resolved components. An approximate magnetic h.f.s. analysis for all terms of $5d^9\,6p$ and $5d^8\,6s^2$ has been made for Hg^{199}. This analysis was made on the assumption that components of even isotopes always preserve the same relative spacing. The assumption does not appear to be strictly valid in a few cases, the largest departure apparently occurring in lines measured by Mrozowski involving the $5d^8\,^4_{\frac{1}{2}}\,^3_{\frac{3}{2}}\,6s^2|_0$ term (and possibly in two other lines). The magnetic h.f.s. is compared with that expected for *jj*-coupling, and it conforms moderately well, but there is evidence of intermediate coupling effects in both configurations, especially $5d^9\,6p$, and in one term at least of this configuration there is also indication of a small perturbation from $5d^8\,6s\,6p$. By deducing the nuclear magnetic moment of Hg^{199} the results are shown to be tolerably consistent with previous investigations. The isotopic structures are very regular compared with those reported for the isoelectronic Pt I spectrum. Such small irregularities as have been found are discussed; those found in $5d^8\,6s^2$ do not seem to be due to the nuclear "volume" effect. A.

535.338.332 : 539.153

7682. Anomalous fine structure of hydrogen and singly ionised helium. W. E. LAMB, JR. *Rep. Phys. Soc. Progr. Phys.*, **14**, 19–63 (1951).

An account is given of theoretical and spectroscopic studies of the fine structure of the $n = 2$ levels of atomic H and singly ionized He, and of the work of Lamb, Retherford and Skinner in which microwave methods are used to establish deviations from the Dirac theory. A qualitative description of the theoretical explanation in terms of quantum electrodynamic level shifts is followed by comparison with observations. A.

537.527.5 : 535.338.35

7683. The re-absorption of radiation in high pressure Hg discharges. F. RÖSSLER. *Z. Naturforsch.*, **6a**, 263–70 (*May*, 1951) *In German.*

From measurements of the self-absorption of a number of spectral lines in a h.p. Hg discharge, and from the absorption of continuous radiation in the same discharge, excitation temps. could be determined. The latter were ~ 4000–6000°K. The optical measurements and technique are described, and references to earlier work are given.

J. D. CRAGGS

535.338.4

7684. Rotational analysis of the γ band system of the NS molecule. P. B. ZEEMAN. *Canad. J. Phys.*, **29**, 174–85 (*March*, 1951).

The band heads of the NS spectrum discovered in 1932 by Fowler and Bakker have been remeasured on plates taken on a large quartz spectrograph and on first-order grating plates. The (0, 0) and (0, 1) γ bands have been photographed in the 6th, 8th, and 9th orders of a 21-ft concave grating, and a rotational analysis of these bands has been carried out. For the ground state ($^2\Pi$) it was found that $B_e'' = 0{\cdot}7736_4$ cm^{-1}, $a_e'' = 0{\cdot}0061_2$, and $A = 223{\cdot}03$ cm^{-1}. For the upper state the value $B_0'' = 0{\cdot}8267_0$ was obtained. A.

535.338.4

7685. A rotational analysis of the γ-system of the TiO molecule. J. G. PHILLIPS. *Astrophys. J.*; **114**, 152–62 (*July*, 1951).

Rotational analyses have been carried out on the (1–0), (0–0) and (0–1) bands of the γ-system of the TiO molecule, at 6 651, 7 054 and 7 590 Å, respectively. In addition to providing molecular constants the analysis showed that the system was produced by a $^3\Delta - {}^3\Pi$ transition, and not by a $^3\Sigma - {}^3\Pi$ transition, as has been formerly assumed. A.

535.338.4 : 537.525.8

7686. On a new spectrum of a glow discharge in naphthalene vapour. H. SCHÜBER AND L. REINEBECK. *Z. Naturforsch.*, **6a**, 270–5 (*May*, 1951) *In German.*

Discusses some new spectra observed in the excitation of naphthalene vapour in He and H_2 discharges. The new spectra (as in the case of benzol, investigated earlier by the same authors) are, it is suggested, caused by excited molecular fragments, for example, of the form C_2H_x ($x = 1$, 2 or 3). Attention is drawn to the differences between these spectra and the absorption spectra obtained with the same vapours.

J. D. CRAGGS

535.338/.343

7687. Energy transfer between complex molecules. M. M. MOODIE AND C. REID. Letter in *J. Chem. Phys.*, **19**, 986 (*July*, 1951).

If the emission region of the primary absorber overlaps that of the 2nd substance, energy transfer

may occur. The transfer efficiency is greatly enhanced if the 2nd substance is in microcrystalline form.

J. JACOBS

535.339

7688. Filters isolating the 3 125 and 2 537 Å lines of mercury for the photographic study of documents. J. CHANU, E. GUILLEMOT, J. LENOBLE AND G. TENDRON. *C.R. Acad. Sci., Paris*, **233**, 35–7 (*July* 2, 1951) *In French.*

The 3 125 Å line may be isolated by a solution of cobalt and nickel sulphates in a glass cell. The same solution in a quartz cell, combined with another of diphenyl butadiene in ether, will isolate the 2 537 Å line. S. T. HENDERSON

535.341

7689. False absorption bands in the region of 200–230 mμ caused by stray radiation in the Beckman spectrophotometer. L. J. SAIDEL, A. R. GOLDFARB AND W. B. KALT. *Science*, **113**, 683–5 (*June* 15, 1951).

Detection and correction are considered and illustrated for solutions of glycine. R. F. BARROW

535.341

7690. Integrated absorption of the fundamental of CO from measurements using self-broadening of rotational lines. D. WEBER AND S. S. PENNER. Letter in *J. Chem. Phys.*, **19**, 974–5 (*July*, 1951).

The results agree with those obtained using CO–H_2 mixtures. R. F. BARROW

535.341 : 535.337/.338 : 539.133

7691. Studies of the visible absorption band of bromine vapour. G. KORTÜM AND W. LUCK. *Z. Naturforsch.*, **6a**, 305–12 (*June*, 1951) *In German.*

The variations in the apparent extinction coefficient with pressure, and the discrepancies between the results of different authors, are to be attributed to the inapplicability of the laws of absorption to the case of a band-spectrum with discrete line-structure, unless the effects of line-broadening are taken into account. This view is supported by experimental work on the absorption at 5 461 Å: the results can be interpreted to give information about the fine-structure of the spectrum and about the magnitude of the effective molecular diameter. R. F. BARROW

535.341 : 535.337/.338 : 539.133

7692. Studies of the visible absorption band of iodine vapour. W. LUCK. *Z. Naturforsch.*, **6a**, 313–19 (*June*, 1951) *In German.*

Measurements of the apparent extinction coefficient at 5 461 Å are reported. Both positive and negative deviations from Lambert's Law are observed with varying pressure at constant path-length. The introduction of N leads to a blurring of the rotational structure of the spectrum, and at sufficiently high p_{N_2}, Lambert's law is obeyed. See also preceding Abstr.

R. F. BARROW

535.341 : 537.312.5

7693. Optical absorption and photoconductivity in barium oxide. W. W. TYLER AND R. L. SPROULL. *Phys. Rev.*, **83**, 548–55 (*Aug.* 1, 1951).

Measurements of the optical absorption and photoconductivity in BaO single crystals are reported. The threshold photon energy for both processes is 3·8 eV, and the absorption constant at higher energies is at least 10^5 cm^{-1}. A second increase in the absorption constant begins at about 4·8 eV and is not accompanied by photoconductivity. The observed dependence of photoconductivity on temperature and electric field strength indicates space charge effects in limiting current flow. The onset of absorption at 3·8 eV is thought to be due to the production of excitons, with the accompanying photoconductivity due to thermal dissociation of excitons or exciton ionization of impurity centres. A.

535.341–15 : 541.57 : 539.133

7694. The experimental determination of the intensities of infrared absorption bands. IV. Measurements of the stretching vibrations of OCS and CS_2. D. Z. ROBINSON. *J. Chem. Phys.*, **19**, 881–6 (*July*, 1951).

For Pt III, see Abstr. 918 (1948). The absolute intensity of the infrared stretching vibrations of the molecules CS_2 and OCS have been measured. For CS_2, the intensity of ν_3 was found to be $7\,560\times10^{10}$ cycles sec^{-1} (cm of vapour at N.T.P.)$^{-1}$. For OCS, the results were 110 and $7\,900\times10^{10}$ for ν_1 and ν_3. A normal co-ordinate analysis of the stretching vibrations of OCS was carried out to obtain $\partial\mu/\partial r$ for the bonds and to compare them with those for CS_2 and the previously obtained results for CO_2. The results for a reasonable value of the interaction constant were 6·7 and $4{\cdot}3\times10^{-10}$ e.s.u. for the CO and CS bonds, while in CO_2 and CS_2 they were 6·0 and $5{\cdot}6\times10^{-10}$ e.s.u. The bearing of these results on the amount of resonance in OCS is discussed. Arguments are presented which suggest that, in spite of the electronegativity difference between O and S, resonance in OCS is not markedly different from that in CO_2 and CS_2. A.

535.342

7695. The validity of the Lambert–Beer law. W. LUCK. *Z. Naturforsch.*, **6a**, 191–202 (*April*, 1951). *In German.*

A kinetic derivation of the Beer–Lambert law, and its validity range. A general formula for the absorption of overlapping spectral lines is also given, which can be used to describe the transition from a line spectrum to a continuum. C. TURNER.

535.343

7696. Natural hypsochromic shifts. A. PULLMAN AND B. PULLMAN. *Disc. Faraday Soc.*, *No.* 9, 46–52 (1950).

The name of *natural* hypsochromic shifts is being given to hypsochromic shifts of the longest wavelength of absorption which are being produced by electronic factors alone and are thus independent of steric interference with coplanarity. These natural hypsochromic shifts may be brought about in the same way as the natural bathochromic ones by appropriately choosing the basic molecular skeleton. They may be produced by increasing the size of a conjugated system, by alkylation, by dehydrogenation of a partially saturated system, by replacement of a double bond by a triple one and by internal strain. Numerous examples are quoted and it is shown that simple molecular orbital calculations account satisfactorily for the observed facts. A.

535.343

7697. The absorption spectroscopy of substances of short life. G. PORTER. *Disc. Faraday Soc., No.* 9, 60–9 (1950).

The experimental methods available for the absorption spectroscopy of free radicals are critically discussed with special reference to flash photolysis and spectroscopy. Some free radical spectra which have been obtained in this way are described and values are given for the dissociation energies and vibration frequencies in the upper and lower states of the ClO, SH and SD radicals. A.

535.343

7698. Localization of the electronic lines in continuous absorption spectra by the temperature-effect. S. BRODERSEN AND A. LANGSETH. *K. Danske Vidensk. Selsk. Mat-fys. Medd.*, **26** (*No.* 3) 55 *pp.* (1951).

A method of successive approximations to localize the $(0 \rightarrow 0)$-frequency lines by measurements of the temperature effect. The theory, based on the Boltzmann distribution law, agrees satisfactorily with the experimental results for 9 substances (mostly benzene and naphthalene derivatives). C. TURNER

535.343 : 535.375.5

7699. Formation of complexes in benzene–oxalyl chloride solutions. B. D. SAKSENA AND R. E. KAGARISE. *J. Chem. Phys.*, **19**, 994–9 (*Aug.*, 1951).

Extinction coefficients have been obtained for solutions of oxalyl chloride diluted with benzene, *n*-heptane, and *me*-cyclohexane; and for solutions of diacetyl, acetyl bromide, acetyl chloride, α-methyl acrolein and crotonaldehyde diluted with benzene and *n*-heptane. It has been possible to correlate the observed data in the infrared, Raman and ultraviolet spectra of oxalyl chloride-benzene solutions by postulating a complex formation of the type $Ar^+[COCl]_2^-$. A.

535.343–14

7700. On the absorption of u.h.f. radio waves by some aliphatic ketones. S. N. SEN. *Indian J. Phys.*, **25**, 25–32 (*Jan.*, 1951).

The absorption of u.h.f. radiowaves by diethyl ketone, dinormal propyl ketone and ethyl isobutyl ketone at temperatures varying from 0°C to 95°C has been investigated in the region 250–510 Mc/s by the optical method. An absorption maximum has been observed in each case. The centres of the absorption peaks observed in the case of the three liquids at 30°C are at 330, 295 and 250 Mc/s respectively. The absorption coefficient, calculated at the centre of the band observed at 30°C, is of the same order of magnitude in all the cases as that calculated on Debye's theory. The results are discussed in the light of the hypothesis put forward earlier by Sirkar and Sen that the permanent electric moment of the molecule is affected by the intermolecular field as the molecule executes rotatory oscillation in the liquid. A.

535.343–14

7701. Remark on the rotational method and the method of perturbations in the ultra-Hertzian region. Apparatus for measuring the absorption of vapours for frequencies near 10 000 Mc/s. R. FREYMANN. *Physica*, **17**, 328–32 (*March–April*, 1951) *In French.*

Points out the importance of short wavelength absorption for investigating molecular interactions and freedom of rotation of water of crystallization. Brief description of atmospheric pressure gas absorption apparatus at 10 000 Mc/s. D. H. WHIFFEN

535.343–14

7702. Ultra-Hertzian absorption of alums and ammonium sulphate and the spectral representation $\log \nu_c - T$. M. FREYMANN, M.-T. ROLLAND AND R. FREYMANN. *C.R. Acad. Sci., Paris*, **232**, 2312–13 (*June* 18, 1951) *In French.*

The low-temperature absorption observed and earlier results are given in a new graphical form with $\log \nu_c$ and T as ordinates and abscissa. D. H. WHIFFEN

535.343–15

7703. Infra-red spectra of organic thiophosphates. R. C. GORE. *Disc. Faraday Soc., No.* 9, 138–43 (1950).

Over 100 organic thiophosphates and related molecules were investigated. The regions of particular interest were those of the characteristic infrared absorption for the P → O, the P → S and the C—S—P linkages which could furnish spectroscopic evidence for the presence of those groups in molecules of doubtful structure. It was thought probable that the P → O and P → S linkages would exhibit sufficiently characteristic absorption to be recognizable but that the C—S—P linkage might prove to be less characteristic. A.

535.343–15

7704. Internal rotation in zinc dimethyl and mercury dimethyl. D. R. J. BOYD, H. W. THOMPSON AND R. L. WILLIAMS. *Disc. Faraday Soc., No.* 9, 154–60 (1950).

Vibrational absorption bands near 3μ have been measured for zinc dimethyl and mercury dimethyl using high dispersion. Analysis of the perpendicular bands suggests that the results are explained well by the assumption of essentially free internal rotation of the methyl group in these molecules. A.

535.343–15

7705. Infra-red spectra of hydroxylic compounds. R. MECKE. *Disc. Faraday Soc., No.* 9, 161–77 (1950).

The following problems were investigated: (i) the nature of the H bond and comparison with thermal and dielectric measurements; (ii) the influence of solvents on compounds with H bonds and the effect of the proton-attracting power of these solvents; (iii) i.r. absorption measurement for the determination of the dipole moments (bond moments) of different XH bonds and the changes brought about by inter- and intramolecular action with other molecules. A.

535.343–15

7706. The infra-red spectra of complex molecules. H. W. THOMPSON, D. L. NICHOLSON AND L. N. SHORT. *Disc. Faraday Soc., No.* 9, 222–35 (1950).

Infrared spectroscopy is applied to complex molecules for analysis and structural problems. Characteristic frequencies of groups sometimes facilitate their identification. Examples are given from recent work on polymers, cellulose and related compounds, carbohydrates, amides, urethanes, amino acids, peptides and derivatives of pyrimidine. A.

535.343–15

7707. The infra-red spectrum of ethylene polymers. L. H. Cross, R. B. Richards and H. A. Willis. *Disc. Faraday Soc., No.* 9, 235–45 (1950).

Infra-red methods have been devised for the determination in ethylene polymers of methyl group concentration, the type and amount of unsaturation, and the nature and quantity of oxygen containing groups. These determinations are important in considerations of the physical properties, polymerization mechanism and sensitivity to chemical attack of the polymers. A strong correlation between the extent of chain branching and the degree of crystallinity has been established for higher molecular weight polymers. Unsaturation determinations on a series of fractions covering a wide range of molecular weights show that the total number of double bonds per molecule is of the order of 0·3 to 0·4 both for original polymer and for the fractions. Whilst the $RR'C{=}CH_2$ type of unsaturation is most common in direct polymers of ethylene, the $RCH{=}CH_2$ type is prominent in low molecular weight pyrolysed polythenes and in photo-oxidized polyethylenes. The oxygen-containing groups found by infra-red methods in natural or oxidized polyethylene are mainly ketonic or aldehydic, though some hydroxyl exists. A.

535.343–15

7708. Some problems in the interpretation of the infra-red spectra of large molecules. G. B. B. M. Sutherland. *Disc. Faraday Soc., No.* 9, 274–81 (1950).

The principles governing the i.r. method of investigating the structure of large molecules are reviewed. It is emphasized that the method will continue to lack preciseness until the various factors affecting the constancy of characteristic group frequencies have been more fully investigated. Attention is drawn to the uncertainties in the detection of OH and NH bonds under certain conditions because of insufficient knowledge of the characteristic deformation frequencies of these groups. A.

535.343–15

7709. Contribution to the study of the absorption of methyl halides in the 1·6 μ region. R. Mathis-Noël. *J. Phys. Radium*, **12**, 550–3 (*April*, 1951) *In French.*

On the high frequency side a || band (*b*) and a ⊥ one (*c*) which is $2\nu_2$ are reported. Passing from Cl to B and I (*b*) changes and the *Q* branch disappears. On the low frequency side a group of ⊥ bands is observed which are due to double Fermi resonance of 1 ⊥ fundamental with several || ones. J. Jacobs

535.343–15

7710. Infrared and mass spectra of some deuterium-containing derivatives of propane. F. E. Condon, H. L. McMurry and V. Thornton. *J. Chem. Phys.*, **19**, 1010–13 (*Aug.*, 1951).

Infrared and mass spectra of 2-deutero–2-propanol (from acetone and lithium aluminium deuteride), 2-chloro–2-deuteropropane (from 2-deutero–2-propanol and concentrated HCl and $ZnCl_2$), 2,2-dideuteropropane (from 2-chloro–2-deuteropropane via the Grignard reagent and D_2O), and 2-deutero–2-methylpropane (from *t*-butylmagnesium chloride and D_2O) are presented in comparison with the infrared and mass spectra of the corresponding compounds not substituted with deuterium. A.

535.343–15

7711. The infrared spectra of propane and its symmetrical deuterium substituted analogs. H. L. McMurry and V. Thornton. *J. Chem. Phys.*, **19**, 1014–18 (*Aug.*, 1951).

The infrared spectra of 2,2-dideuteropropane, 1,1,1,3,3,3-hexadeuteropropane, and octadeuteropropane are presented, together with that of propane for comparison. Complete assignments are proposed for the frequencies of the vibrations belonging to species A_1 and B_1, and partial assignments for the vibrations belonging to species B_2, in these molecules. They show that some low frequency vibrations (below 1 350 cm^{-1}) in the deuterium substituted molecules cannot be described adequately in terms of simple group motions. The results suggest that this is true also for the corresponding vibrations in propane. A.

535.343–15 : 535.375.5

7712. Infra-red and Raman spectra of 1 : 3 : 5-trifluorobenzene. J. R. Nielsen, C.-Y. Liang and D. C. Smith. *Disc. Faraday Soc., No.* 9, 177–87 (1950).

The i.r. spectrum of 1 : 3 : 5-trifluorobenzene in the gaseous and liquid states has been investigated between 2 and 22·5 μ by means of a prism spectrometer of high resolution. The Raman spectrum of the liquid has been studied with a three-prism glass spectrograph of linear dispersion 15 Å/mm at 4 358 Å. The 17 fundamental vibration frequencies that are active in i.r. absorption or in the Raman effect have been assigned and tentative values given for two of the three inactive fundamentals. The observed spectra have been interpreted in detail. A.

535.343–15 : 535.375.5

7713. Vibrational spectra of carbon and silicon tetramethyl and their monodeutero derivatives. D. H. Rank, B. D. Saksena and E. R. Shull. *Disc. Faraday Soc., No.* 9, 187–96 (1950).

Infra-red spectra in the region 3 μ to 15 μ and Raman spectra, along with the polarizations and intensities, have been obtained for C and Si tetramethyl and their monodeuterium derivatives. The infra-red spectra have been obtained in the gas phase and the Raman spectra in the liquid phase. Assignments of the vibrational frequencies occurring in the spectra of these molecules have been made as completely as the experimental data allow. The argument for the assignment of 922 cm^{-1} to n_4 of the skeletal framework vibrations of tetramethylmethane appears to be quite strong as the result of the new experimental data. It seems necessary to assign 1 250 cm^{-1}, the other alternative frequency for the n_4 assignment, to ν (CH) for a large number of reasons. The behaviour of the totally symmetric vibrations of these molecules casts grave doubts upon the correctness of making force constant calculations treating the methyl group as a single atom in dealing with molecules of this type. A.

535.343-15 : 538.224 : 541.67

7714. Contribution to the study of the structure of the persulphuric ion (magnetochemistry and infra-red absorption). P. PASCAL, C. DUVAL, J. LECOMTE AND A. PACAULT. *C.R. Acad. Sci., Paris*, **233**, 118–20 (*July* 9, 1951) *In French.*

In the persulphuric ion $(SO_4^-)_n$ an even value of n is indicated by the diamagnetism of the K and NH_4 persulphates and by correlation of the i.r. absorption spectra of these persulphates with those of K_2SO_4 and $(NH_4)_2SO_4$. W. R. ANGUS

535.343–15 : 537.375.5

7715. Rotational isomerism in oxalyl chloride (ClOC–COCl). B. D. SAKSENA AND R. E. KAGARISE. *J. Chem. Phys.*, **19**, 987–93 (*Aug.*, 1951).

The Raman spectrum of liquid and the i.r. absorption spectrum of liquid and gaseous oxalyl chloride have been investigated. The effects of dilution in benzene and of temperature upon the spectra were also studied. A tentative assignment has been made of all fundamental frequencies. From temperature intensity measurements in the Raman effect, the value of ΔH for the reaction C_{2h} oxalyl chloride—C_{2v} oxalyl chloride was found to be 2·8 kcal/mole. It is suggested that the high value of the depolarization factor for Rayleigh scattering indicates planar structure. A.

535.343–32

7716. The ultraviolet spectrum of oxalyl chloride. B. D. SAKSENA AND R. E. KAGARISE. *J. Chem. Phys.*, **19**, 999–1001 (*Aug.*, 1951).

The ultraviolet spectrum of oxalyl chloride in the liquid and vapour phases has been investigated in the region 380–280 mμ. The spectrum of the vapour shows considerable structure and progressions of 70, 390, 940, 1 380 and 1 420 cm^{-1} are observed. The liquid spectrum in this region shows several maxima having small extinction coefficients. Beyond 280 mμ the extinction coefficient increases rapidly. A.

535.343–32

7717. Discussion of the lowest singlet transition in naphthalene as a forbidden transition $A_{1g} - A_{1g}$ and remarks on the higher singlet levels. H. SPONER AND G. P. NORDHEIM. *Disc. Faraday Soc., No.* 9, 19–26 (1950).

The absorption system of naphthalene at 3 200–2 900 Å is interpreted as $^1A_{1g} - {}^1A_{1g}$ transition. The i.r. active vibration of 568 cm^{-1} is tentatively suggested as vibration that makes the forbidden transition allowed in second order. In making this analysis, experimental data on absorption and fluorescence in the different states of aggregation of naphthalene and new results obtained for heavy naphthalene were used. The 0–0 band of the next higher absorption system at 2 900–2 500 Å is located at 35 910 cm^{-1} and of the third absorption system at about 45 100 cm^{-1}, both for the vapour. A brief comparison with theoretical results is given. A.

535.343–32

7718. Polymer types and specific absorptions in the ultra-violet by hydrogen-bridged amides and alcohols with application to the protein structure problem. G. A. ANSLOW. *Disc. Faraday Soc., No.* 9, 299–318 (1950).

The objective of these investigations was to locate and to attempt the identification of the origins of the absorption continua, which appear in the ultra-violet spectra of hydrogen-bridged molecules, correlating these with information from other types of physical measurements; to explore the nature of the excitation process and to establish equations giving the minimum frequency of the respective continua; and finally to correlate the findings with the spectra of proteins. The principal absorptions below 250 mμ in amides and alcohols prove to be of electronic-vibrational origin, the onset frequencies and respective types depending on the dimer or polymer type of associated molecule. Polymeric alcohols appear to be associated through ionic OH^+ bonds. Weak ground state dissociation of OH . . . O with onset near 35 000 cm^{-1} seems to be characteristic of bound water. CH . . . N and CH . . . O association effects are discussed. Applications are made to the spectra of the proteins, zein and gelatin. A.

535.343–32

7719. The absorption spectrum of bismuth sulphide BiS. P. K. SUR. *Indian J. Phys.*, **25**, 65–72 (*Feb.*, 1951).

Two band systems of the BiS molecule have been obtained in absorption in the near and farther u.v. regions ($\lambda\lambda$3056 — 2351) and ($\lambda\lambda$2312 — 2133). Most of the bands in the two systems have been classified, and their vibrational levels assigned. A number of bands which remain unclassified are listed. A.

535.343–32 : 539.13

7720. On the theory of the metallic model of polymethine molecules taking account of the ionization. Application to the ultraviolet spectrum. S. NIKITINE AND S. G. EL KOMOSS. Letter in *J. Phys. Radium*, **12**, 635–6 (*May*, 1951) *In French.*

The potential is $-V_0$ along the length L of the chain and zero at its ends. The energies of electronic states now depend on 2 parameters, L and V_0, which are fixed using the 1st u.v. band and the ionization potential. J. JACOBS

535.343.2

7721. Absorption spectrum of crystals at low temperatures. II. Analysis of absorption spectrum of naphthalene crystal. I. TSUJIKAWA AND E. KANDA. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 420–3 (*June*, 1950).

For Pt. I, see Abstr. 4259 (1951). The absorption spectrum of naphthalene crystal at the temperature of liquid H has been analysed. This was impossible at higher temperature due to considerable overlapping of neighbouring bands. Three progressions in the band system between 3 250 Å and 2 950 Å were noticed. The conclusion that this band system is forbidden from consideration of symmetry character of wave function coincides with experimental results. A.

535.343.2 : 537.312.5

Connection between the internal photo effect and light absorption in silver halides salts. *See Abstr.* 7899

535.343.2 : 548.7

7722. Dispersion theory of molecular crystals. II. A. S. DAVYDOV. *J. Exp. Theor. Phys., USSR*, **20**. 760–6 (*Aug.*, 1950) *In Russian.*

For previous Pt, see Abstr. 3052 (1950). It is investigated how far the interaction of intramolecular and rotational vibrations affects the dispersion and absorption curves in the frequency range of intramolecular vibrations. J. JACOBS

535.343.2–15

7723. Infra-red spectra of crystals at low temperatures. D. F. HORNIG. *Disc. Faraday Soc., No.* 9, 115–24 (1950).

Examination of available data, some previously unpublished, shows many of the features expected in low temperature spectra. These include line widths which are frequently less than 10 cm^{-1}, a multiplicity of lines due to the coupling of molecular motions and apparently rigorous selection rules which may be determined from the symmetry of a unit cell. The relative magnitudes of equilibrium and coupling terms in the crystal field are compared. The spectroscopic data are found to be inconsistent with the X-ray structure of crystalline CO_2. A structure for crystalline HCN, not hitherto determined, is obtained which satisfies the i.r. data, possibly uniquely. Combination bands between internal modes and lattice torsions have been observed as well as the torsional fundamentals (NH_3, ND_3). Large changes in intensity occur on crystallization but insufficient data are available to draw quantitative conclusions. A.

535.343.2–15

7724. Infra-red adsorption spectra of metallic acetyl-acetonates. J. LECOMTE. *Disc. Faraday Soc., No.* 9, 125–31 (1950).

The absorption spectra of 7 metallic acetyl-acetonates have been obtained from the powders in the region 525–1 750 cm^{-1}. These experimental results are interpreted in terms of the vibrations of the carbon chain and the CH_2 or CH_3 groups, and taking account of the keto-enol isomerism. The changes caused in the spectra by the presence of the metal are stressed. From the i.r. spectra it is deduced that the acetyl-acetonates behave as complexes and that a cyclic formula is most probable. A.

535.343.2–15

7725. Evidence of chain folding in polypeptides and proteins. A. ELLIOTT AND E. J. AMBROSE. *Disc. Faraday Soc., No.* 9, 246–51 (1950).

Observations of the i.r. spectrum of proteins and polypeptides in the overtone region, using polarized radiation, have shown that a band at approximately 4 840 cm^{-1} can be used to distinguish between extended and folded configurations, even in the presence of liquid water. These observations are used to interpret some observations on single haemoglobin crystals, from which it appears that the N–H bonds have a preferential orientation along the *a* crystallographic axis. The results are consistent with previously published work by Perutz. Some observations on orientation phenomena in a synthetic polypeptide solution are described. A.

535.343.2–15

7726. The interpretation of the vibrational spectra of the *n*-paraffins. J. K. BROWN, N. SHEPPARD AND D. M. SIMPSON. *Disc. Faraday Soc.*, No. 9, 261–74 (1950).

Infra-red spectra in the crystalline state from 1 500 to 700 cm^{-1} are presented for the even numbered paraffins from *n*-octane to *n*-tetradecane, and also for *n*-nonane. Detailed consideration is given to the assignment of the collected i.r. and Raman spectra of the planar *trans* isomer of *n*-butane, and partial interpretations are attempted of the less complete experimental data available for the planar zig-zag isomers of the other even-numbered paraffins to *n*-tetradecane. The skeletal stretching modes are shown to occur between 1 150 and 880 cm^{-1} for the paraffins with more than 6 carbon atoms, and 5 series of such frequencies which run through the spectra of the different hydrocarbons have been picked out and identified. Series of CH_2 wagging and twisting modes occur between 1 350 and 1 150 cm^{-1}; CH_2 rocking modes, which originate near 700 cm^{-1} in the i.r. spectra of the smaller molecules, give rise to series of absorptions spreading to 1 000 cm^{-1} in the spectra of the larger molecules. The in-plane methyl wagging modes are found near 1 060 cm^{-1}. The present position with respect to the theoretical estimation of the skeletal frequencies is discussed. The i.r. and Raman spectra of polythene are discussed. A.

535.343.2–15

7727. The application of polarized infra-red radiation to problems in molecular structure. I. Polyisoprenes. G. B. B. M. SUTHERLAND AND A. V. JONES. *Disc. Faraday Soc., No.* 9, 281–90 (1950).

The i.r. spectra of rubber and of both forms of gutta-percha have been investigated between 5 and 15 μ under various conditions. When rubber and gutta-percha are each in the amorphous state, their i.r. spectra are closely similar although not identical; in the crystalline state, marked differences occur between the spectra of these three forms of polyisoprene. Using polarized radiation, the dichroic ratios of bands which can be assigned with certainty are in general qualitative agreement with the crystalline structures proposed by Bunn. The spectrum of rubber crystallized by freezing has been examined at low temperatures and it is shown that apparent intensity changes occur in certain absorption bands on crystallization. The importance of this effect in using i.r. methods to estimate the degree of crystallinity produced in rubber by stretching is emphasized. Assignments of a few of the main bands are discussed but no attempt is made to give a complete interpretation of the spectra. A.

535.343.2–15

7728. Infra-red analysis of rubber derivatives. G. SALOMON, A. C. VAN DER SCHEE, J. A. A. KETELAAR AND B. J. VAN EYK. *Disc. Faraday Soc., No.* 9, 291–9 (1950).

Changes in the intensity of the double bond frequencies (6·0 μ, 10·3 μ, 11 μ, 11·9 μ) and the CH_3 bending vibration occurring during the chlorination of natural rubber and the formation of various rubber derivatives have been studied. The significance of

vinylic groups for the ageing properties of rubber derivatives is pointed out. The intensity of the 6·0 μ C=C stretching frequency cannot be used as a relative measure of unsaturation, as it depends on many other factors. It is, however, remarkable that chlorinated rubber with 70% Cl has still a measurable absorption at 6 μ. The relative intensity of the 7·25 μ CH_3 bending vibration has been estimated from the k_{CH_3}/k_{CH_2} ratio. Controlled addition of HCl or Cl_2 to the double bonds of rubber leads to an increased intensity at 7·25 μ, while it is reduced in technical chlorinated rubber, of similar chlorine content. A.

535.343.2–15

7729. Remarks on the study of infra-red absorption by the powder method. J.-P. Mathieu. Letter in *J. Phys. Radium*, **12**, 632–3 (*May*, 1951) *In French.*

Close to strong residual rays, reflection by ground particles is very dependent on particle size because of interference effects, and transmission minima may vary as with NaCl, where the minimum is 61·1 μ for the finest layers and 60 μ for coarser powders.

D. H. Whiffen

535.343.2–15

7730. Infra-red spectroscopic studies of globular protein structure. E. J. Ambrose and A. Elliott. *Proc. Roy. Soc. A*, **208**, 75–90 (*Aug.* 7, 1951).

The i.r. absorption bands associated with the peptide groups in globular proteins, folded synthetic polypeptides and α-fibrous proteins are very similar. The spectra of denatured globular proteins, extended chain synthetic polypeptides and β-fibrous proteins are also very similar. Denatured fibrous insulin is shown by polarized-beam techniques to consist of extended β chains lying perpendicular to the fibril axis, with a layer structure involving inter-chain hydrogen bonded grids. Rhombohedral insulin crystals show dichroism consistent with an arrangement of folded chains packed perpendicular to the trigonal axis. A mechanism to explain denaturation of proteins is suggested in which precipitation is caused by a change from intra-chain to inter-chain H bonds. A method for investigating chain configurations of proteins in aqueous solution is described. A.

535.343.2–15

7731. Determination of the degree of polymerization of metallic mineral salts by means of infrared absorption spectra. C. Duval and J. Lecomte. *C.R. Acad. Sci., Paris*, **232**, 2306–8 (*June* 18, 1951) *In French.*

The multiplication of lines between 6 and 16 μ for metaborates suggests $(BO_2)_2$ for fresh samples. For older ones the modified spectrum warrants $(BO_2)_n$. In orthoborates also the lines cannot be attributed to the BO_3 ion but suggest polymerization. J. Jacobs

535.343.2–15 : 539.264

7732. Infra-red and X-ray studies of chitin. S. E. Darmon and K. M. Rudall. *Disc. Faraday Soc., No.* 9, 251–60 (1950).

The absorption spectra of chitin, chitosan, chitin nitrate and wood cellulose have been recorded in the region 3 600 cm^{-1} to 750 cm^{-1}, using polarized radiation. A preliminary interpretation of the spectra, in conjunction with the X-ray data, has increased our knowledge of the detailed structure of chitin. The principal feature is hydrogen bonding between CO . NH groups of adjacent amino-acetyl side-chains, to form linked piles of chitin chains within the crystalline regions. But consistent with the particular symmetry, this type of linkage seems to occur between only some of the amino-acetyl groups (presumably half of them). The remaining acetyl groups are bonded differently and the evidence points to a linkage of the type CO . . . HO. As a result of the progressive deacetylation which occurs during chitosan formation, the principal inter-chain bonding is of the type OH . . . OH, as in cellulose. The results of these investigations form a basis for an understanding of the role of *N*-acetylhexosamines in the inter-chain bonding of polysaccharides. A.

535.343.2–32

7733. Observations of proteins in polarized ultra-violet light. M. F. Perutz, M. Jope and R. Barer. *Disc. Faraday Soc., No.* 9, 423–7 (1951).

535.343.2/.3 -15

7734. Some infra-red spectroscopic studies of rotational isomerism. J. K. Brown and N. Sheppard. *Disc. Faraday Soc., No.* 9, 144–54 (1950).

Infra-red spectra in the crystalline state are reported for 1 : 2-dibromoethane, 1 : 4-dibromobutane, *n*-propyl bromide and *n*-butyl bromide between 1 500 and 700 cm^{-1}; also for *n*-butyl, *n*-hexyl and *n*-octyl alcohol from 1 200 to 850 cm^{-1}. All these spectra showed considerable simplification when compared with the corresponding spectra of the liquids. The complexity of the liquid state spectra is caused by the presence of several rotational isomeric configurations, only one of which is allowed in the solid state. The solid state spectra are completely analysed for 1 : 2-dibromoethane and 1 : 4-dibromobutane, and are shown to be consistent with the presence of a single configuration in the solid state for *n*-propyl and *n*-butyl bromide. Strong absorptions between 1 070 and 880 cm^{-1} in the spectra of the alcohols in the crystalline state are interpreted as being mainly caused by the skeletal stretching modes of the planar zig-zag chain. The investigation of the spectra in the crystalline state of molecules which exhibit rotational isomerism will probably be of general use in the analysis of their spectra. Some advantages and limitations of this method are discussed. A.

535.343.3/.4–15 : 535.375.5 : 539.132

7735. Substituted ethanes. III. Raman and infrared spectra, assignments, force constants, and calculated thermodynamic properties for 1,1,1-trichloroethane. M. Z. El-Sabban, A. G. Meister and F. F. Cleveland. *J. Chem. Phys.*, **19**, 855–64 (*July*, 1951).

For Pt II, see Abstr. 957 (1951). Raman displacements, semi-quantitative relative intensities, and quantitative depolarization factors for liquid 1,1,1-trichloroethane, and i.r. wave numbers and percentage absorption for both the liquid and gaseous states in the region 400–5 000 cm^{-1} were obtained and compared with previous data. A normal co-ordinate treatment, using the Wilson *FG* matrix method, was carried out, and a reasonable set of force constants was determined. Assignments were made for all

observed bands of the i.r. and Raman spectra. The heat content, free energy, entropy and heat capacity at constant pressure were calculated for 9 temperatures in the range 298·16° to 1 000°K. A comparison of calculated and observed entropy values indicated that the potential barrier hindering the internal rotation is about 2 840 cal/mole, which leads to a value of $205 \pm 20\ cm^{-1}$ for the torsional frequency and to $0{\cdot}786 \times 10^{-12}$ erg/radian for the torsional force constant. A.

535.343.3–15

7736. Infra-red absorption spectra of twelve substituted benzene derivatives from 15 to 40 microns. E. K. PLYLER. *Disc. Faraday Soc., No.* 9, 100–8 (1950).

These have been measured, in the liquid state, to observe the location of the bands and to compare the experimental values with those that have been theoretically predicted. The substituted benzenes included were the mono-substituted halogen benzenes, toluene, ethylbenzene, the 3 dimethylbenzene isomers, and the 3 trimethylbenzene isomers, all of which were highly purified samples. Assignments of the observed bands of benzene are discussed, and a table is given listing the observed bands and their classifications for the singly and doubly substituted benzenes. A list is also given of the observed bands of the trimethylbenzene isomers, and their classifications are discussed. A brief discussion of the experimental method used in the long wavelength measurements with the thallium bromide-iodide prism is included. A.

535.343.3–15 : 541.651

7737. Characterization of benzene ring substitution by infrared spectra. C. W. YOUNG, R. B. DUVALL AND N. WRIGHT. *Analyt. Chem.*, **23**, 709–14 (*May*, 1951).

The spectra of benzene derivatives exhibit absorption patterns in the 5- to 6-micron region which are characteristic of the number and location of substituent groups on the benzene ring. These patterns, rather than specific frequencies, offer the key to the interpretation of the substituent configurations. The atomic constitution or chemical functionality of the substituent groups has only a minor influence on the appearance of the patterns. A.

535.343.32

7738. Solvent induced frequency shifts for catacondensed aromatics. N. D. COGGESHALL AND A. POZEFSKY. Letter in *J. Chem. Phys.*, **19**, 980–1 (*July*, 1951).

The variation of the position of the $22\,000\ cm^{-1}$ band of naphthacene in solvents of different refractive index is described, and results are given of average frequency shifts between paraffin and benzene solutions for several aromatics. R. F. BARROW

535.343.32 : 538.615

7739. Studies of Zeeman effects from solutions of europium and neodymium salts. G. J. ROTARIU. Letter in *J. Chem. Phys.*, **19**, 977–8 (*July*, 1951).

Presents results of an investigation on Zeeman spectra of (1) aqueous and alcoholic solutions of $Eu(NO_3)_3$, the latter at −22°c and −80°c, (2) aqueous solutions of the same salt, and of $Nd(NO_3)_3$, in complexes with ethylenediamine tetra-acetate.

F. LACHMAN

535.343.32–15

7740. A new infrared band characteristic of amino-acids and of amino-acid hydrochlorides. M.-L. JOSIEN AND N. FUSON. *C.R. Acad. Sci., Paris*, **232**, 2016–18 (*May* 28, 1951) *In French.*

A strong band at $1\,215\ cm^{-1}$ is considered to be characteristic of the –COOH group. R. F. BARROW

535.343.32–32

7741. The ultraviolet spectra of aneurin and of cocarboxylase in presence of ethyl pyruvate and of a mixture of acetaldehyde and pyruvic acid. C. DE LOZÉ. *C.R. Acad. Sci., Paris*, **232**, 2302–4 (*June* 18, 1951) *In French.*

535.343.4

7742. A new band system of bismuth chloride in absorption. P. K. SUR. *Proc. Nat. Acad. Sci. India, Sect. A*, **19** (*Pt* 1) 16–22 (1950).

This has been observed in the region λλ2400–λλ2200. A few bands due to the isotopic molecule $BiCl^{37}$ were also recorded in fair agreement with the observed and calculated values. The correctness of the assignment of the new system to the BiCl molecule is confirmed by the agreement of the constants of the ground level with those of the common ground level of the two systems of bands of the BiCl molecule observed in absorption in the blue-green region between λλ5400–λλ4300, and in the violet region λλ4000–λλ3600 by Frank Morgan, and later by S. K. Ray. A.

535.343.4

7743. New bands of SiCl. S. N. GARG. *Proc. Nat. Acad. Sci. India, Sect. A*, **19** (*Pt* 1) 23–33 (1950).

All are shown to belong to the $B \rightarrow X$ system at λ2942 Å. A revised analysis has been given for this system. All the unassigned bands which do not find place in the existing analysis and those which have till now been included anomalously in the system $B \rightarrow X$ have been shown to form another system $A \rightarrow X$. The electronic doublet separation of $207{\cdot}9\ cm^{-1}$ occurs in the system $A \rightarrow X$ also, showing thereby that it occurs in the state X. A.

535.343.4–14

7744. Determination of molecular structure with microwave spectroscopy. E. B. WILSON, JR. *Disc. Faraday Soc., No.* 9, 108–14 (1950).

The characteristics and limitations of microwave spectroscopy as a tool for the determination of the structure of simple molecules in the vapour state are discussed. The great advantages are the tremendous frequency resolving power and great precision. The applications of the method to the measurement of moments of inertia, interatomic distances, dipole moments, barriers hindering internal torsion, magnetic moments and valence information from hyperfine structure are outlined. A.

535.343.4–14

7745. Vibration-rotation transitions of C_2D_2 in the microwave region. R. M. TALLEY AND A. H. NIELSEN. Letter in *J. Chem. Phys.*, **19**, 805–6 (*June*, 1951).

The possibility of observing vibration-rotation

lines for C_2D_2 with a microwave spectrometer is discussed and approximate values of the frequencies given. W. R. ANGUS

535.343.4–14

7746. The microwave spectra of the deutero-ammonias. M. T. WEISS AND M. W. P. STRANDBERG. *Phys. Rev.*, **83**, 567–75 (*Aug.* 1, 1951).

Measurements of the inversion-rotation spectra of the deutero-ammonias have been made in the 4 000 Mc/s to 80 000 Mc/s region. Fifty lines of NH_2D and NHD_2 have been measured and identified by means of the Stark effect. As expected, results show that for these molecules, only simultaneous rotational and inversion transitions can be observed. Thus, corresponding to each $J_\tau \rightarrow J_{\tau'}$ transition two absorption lines can be observed, separated by either twice the rotational energy separation or twice the inversion splitting of the levels involved. From the observations the inversion splittings of the partially deuterated molecules can be calculated and are found to be in good agreement with the Dennison and Uhlenbeck inversion doubling theory. Thus, the inversion splittings for the ammonia molecules are approximately as follows: 24 000 Mc/s for NH_3; 12 000 Mc/s for NH_2D; 5 000 Mc/s for NHD_2; 2 000 Mc/s for ND_3. The results are also in agreement with the structural parameters of ammonia as given by Herzberg. The sign of the nuclear quadrupole coupling constant was also measured and found to be negative, as expected. The centrifugal distortion for both rotation and inversion states has been experimentally determined. A.

535.343.4–14 : 538.569

The absorption of microwaves in excited hydrogen. *See Abstr.* 8071

535.343.4–14 : 539.181 : 539.132

Radiofrequency spectra of H_2 and D_2 by a new molecular beam resonance method. *See Abstr.* 8105

535.343.4–15

7747. A study of the low frequency fundamental bands in the spectrum of AsH_3. H. H. NIELSEN. *Disc. Faraday Soc.*, *No.* 9, 85–92 (1950).

An analysis of the 2 l.f. fundamental bands ν_3 and ν_4 in AsH_3 is attempted and conclusions drawn in a previous paper [Abstr. 2420 (1949)] are thereby tested. A.

535.343.4–15

7748. Infra-red spectrum and structure of the HNCO molecule. G. HERZBERG AND C. REID. *Disc. Faraday Soc.*, *No.* 9, 92–9 (1950).

The i.r. spectrum of cyanic acid vapour from 400 to 14 000 cm^{-1} has been studied with medium and, above 8 000 cm^{-1}, with high dispersion. Comparison of the spectrum with that of related molecules shows that free cyanic acid in the vapour phase consists only of HNCO molecules (isocyanic acid). The structure of the observed bands shows conclusively that the NCO group in HNCO is very nearly linear and that the H atom is off that line. All six fundamentals of HNCO have been found and have been confirmed by the observation of a considerable number of overtone and combination bands. A brief discussion of the spectra of liquid and solid HNCO is included. A.

535.343.4–15

7749. The infra-red absorption spectra of boron-nitrogen compounds. W. C. PRICE, R. D. B. FRASER, T. S. ROBINSON AND H. C. LONGUET-HIGGINS. *Disc. Faraday Soc.*, *No.* 9, 131–7 (1950).

The infra-red spectra of borazole, *N*-trimethyl borazole, aminodimethylborine and trimethylamine-borine are described and interpreted. Analogies are drawn between the spectra of these compounds and those of benzene, mesitylene, *iso*butene and *neo*-pentane respectively, with which they are isoelectronic. The resolution employed enabled a satisfactory analysis to be made of the spectrum of borazole throughout the range from 7 000–400 cm^{-1}. The extremely high intensities of the bands indicate the high polarities of the structures and correlations are made with the strengths of the bands and the corresponding modes of vibration. Certain bands, which can be associated with simple vibrational modes, indicate how the bonds to the H atoms from B, N and C atoms change with the nature of the BN bond. A.

535.343.4–15

7750. Vibration-rotation bands of nitrous oxide. H. W. THOMPSON AND R. L. WILLIAMS. *Proc. Roy. Soc. A*, **208**, 326–31 (*Sept.* 7, 1951).

The infra-red absorption of N_2O gas near 4·5 μ has been re-investigated using high resolving power. The rotational fine structure has been split up and shown to involve two vibrational transitions, one due to absorption of a fundamental from the ground state, and the other to a $\pi \rightarrow \pi$ transition from an excited vibrational level. The transitions have been analysed theoretically and rotational constants obtained. The results serve to emphasize the importance of using more precise wavelength standards for infrared measurements than have been used hitherto, if the rotational constants are to be obtained with accuracy comparable to that achieved by microwave measurements. Excellent agreement with the latter has now been found. A.

535.343.4–15

7751. Intensities of vibration bands. III. Nitrous oxide. H. J. CALLOMON, D. C. MCKEAN AND H. W. THOMPSON. *Proc. Roy. Soc. A*, **208**, 332–41 (*Sept.* 7, 1951).

For Pt II, see Abstr. 4243 (1950). The absolute intensity of the vibration absorption band of N_2O at 4·5 μ has been determined. The procedure involves the measurement of the integrated band area under conditions of complete pressure broadening caused by the addition of excess N_2, and extrapolation of the results to the value corresponding to zero partial pressure of N_2O. This method has been examined critically, and the value obtained, namely $4\,850 \times 10^{10}$ c/cm/atm., seems more satisfactory than earlier estimates. The intensity has been correlated with the polar properties of the N–N and N–O links. The general relationship between integrated band area and total pressure has been discussed. A.

535.343.4–15

7752. Erratum: The intensities of several of the infra-red absorption bands of cyanogen and cyanogen chloride. E. R. NIXON AND P. C. CROSS. Letter in *J. Chem. Phys.*, **19**, 1067 (*Aug.*, 1951).

See Abstr. 961 (1951).

535.343.4–15

7753. Intensities of vibration bands. IV. Carbonyl sulphide and acetylene. H. J. CALLOMON, D. C. MCKEAN AND H. W. THOMPSON. *Proc. Roy. Soc. A*, **208**, 341–51 (*Sept.* 7, 1951).

The intensities of two vibrational absorption bands of COS and C_2H_2 have been measured, using the procedure involving pressure broadening of the bands by adding an inert gas. The results have been used to calculate how the dipole moment of these molecules varies during molecular vibration. The whole spectrum of COS has been re-examined, and one band assigned to an isotopic molecule has been used to calculate an interaction constant in the potential energy function. The values found for $\partial\mu/\partial r$ have been considered in relation to those determined recently for other molecules. The general empirical relationships between absorption intensity and total pressure of gas have been discussed. A.

535.343.4–15 : 539.155.2

7754. Determination of isotope ratios, e.g., in tracer work, by an infrared absorption method. J. M. W. MILATZ, J. C. KLUYVER AND J. HARDEBOL. *J. Chem. Phys.*, **19**, 887–8 (*July*, 1951).

The method is applicable where the substance has strong infrared absorption bands of sufficient isotope shift for the centres of the bands to be distinguished from each other. It is illustrated by the analysis of $C^{13}O_2$. A chamber filled with pure $C^{13}O_2$ is used as a detector; illumination by infrared light chopped at 50 c/s causes detectable pressure variations in a condenser microphone. Insertion in the beam of a cell containing the CO_2 of unknown composition causes a decrease in microphone output proportional to the $C^{13}O_2$ content. C^{13}/C^{12} ratios between 0·011 and 0·1 have been measured with an accuracy of 0·002, and it is hoped to improve this to 1% near 0·11.

535.343.4–32

7755. The ultra-violet absorption spectra of fluorinated toluenes. W. T. CAVE AND H. W. THOMPSON. *Disc. Faraday Soc.*, *No.* 9, 35–45 (1950).

The absorption spectra of some fluorinated toluenes in the vapour phase have been measured in the near ultra-violet. Benzotrifluoride, *m*- and *p*-fluorobenzotrifluoride, *o*-, *m*- and *p*-fluorotoluenes have been studied. A vibrational analysis has been made in each case, and although this is incomplete, important deductions about the values of molecular vibration frequencies have been made. The latter have been correlated with values obtained from the Raman spectra. The most intense progression for each molecule appears to involve a frequency interval which is characteristic of the structural type, and this might be useful for diagnostic purposes with the *o*-, *m*- and *p*-isomers. A.

535.343.4–32

7756. The absorption spectra of some substituted benzenes and naphthalenes in the vacuum ultra-violet. V. J. HAMMOND, W. C. PRICE, J. P. TEEGAN AND A. D. WALSH. *Disc. Faraday Soc.*, *No.* 9, 53–60 (1950).

Vacuum ultra-violet spectra and ionization potential data are given for the molecules, benzene, toluene, ethyl benzene, *iso*propyl benzene, *o*-, *m*-, *p*-xylenes, phenol, monofluorobenzene, benzotrifluoride, *o*-, *m*-, *p*-monofluorotoluene, *m*-fluorobenzotrifluoride, naphthalene and 2-methyl naphthalene. The effect of the nature and position of the substituting groups is discussed and is compared with the effect of solvents in solution spectra. The 2 000 Å absorption region of benzene and its derivatives is interpreted as a Rydberg transition. A.

535.37

7757. Selective reflection from the vapors of the alkali metals. A. C. LAURISTON AND H. L. WELSH. *Canad. J. Phys.*, **29**, 217–26 (*May*, 1951).

Selective reflection from Na, K, Rb and Cs vapours in the neighbourhood of the resonance lines was observed for vapour pressures between 10 mm and 1 atm, using a steel tube with a window of transparent MgO. Reflecting power as a function of frequency was measured by using incident light of continuous spectral distribution. The reflection contour for pressures up to ½ atm is in good agreement with the theory of reflection from an absorbing medium. For each line the damping constant in the dispersion equations varies as the square root of the number of atoms per cm^3, as was found previously for Hg and Cd. For the two members of the resonance doublet the damping constants are proportional to the square roots of the oscillator strengths. In a region about 5 cm^{-1} wide about each resonance frequency the reflected intensity measured experimentally is greater than that calculated. These lines of residual intensity may be due to a second kind of selective reflection. At pressures above ½ atm the observed reflection contour cannot be explained by the simple anomalous dispersion theory. A.

535.37.08 : 535.342

7758. Correction for light absorption in fluorescence and light scattering measurements. J. L. LAUER. Letter in *J. Opt. Soc. Amer.*, **41**, 482–3 (*July*, 1951).

A method of calculating the correction in fluorescence measurements on coloured solutions.

S. T. HENDERSON

535.371

7759. Remarks on the interpretation of the "glow curves" of crystal phosphors. M. SCHÖN. Letter in *Naturwissenschaften*, **38** (*No.* 10) 235 (1951) *In German.*

The effect of non-radiative electron transitions from traps to the valence band of phosphors on their fluorescence, phosphorescence and thermoluminescence is discussed. Absence of long afterglow in ZnS–Ag compared with ZnS–Cu is explained by such transitions. G. F. J. GARLICK

535.371

7760. On the radiationless transitions in sulphide phosphors. M. SCHÖN. *Z. Naturforsch.*, **6a**, 251–5 (*May*, 1951) *In German.*

Radiationless transitions to the ground states of phosphor crystal lattices are identified with electron transitions from electron traps to the valence band.

Quantitative theoretical treatment of relation of luminescence efficiency to excitation intensity, number of traps and number of activator centres shows good agreement with experimental results of other workers.
G. F. J. GARLICK

535.371

7761. Silver as an activator of halophosphate phosphors. P. W. RANBY. *J. Electrochem. Soc.*, **98**, 299–300 (*July*, 1951).

It has been found that the alkaline earth halophosphates can be activated by Ag; Mn can be incorporated as an additional activator. These phosphors show a number of differences from previously known halophosphate phosphors activated, for example, by Sb. The properties of the Ag-activated phosphors are described and compared with those of other halophosphate phosphors. An explanation, based on the position of Ag in the halophosphate lattice, is suggested to account for the differences between Ag- and Sb-activated halophosphate phosphors. A.

535.371

7762. The role of chlorine in the luminescence of ZnS–Cu phosphors. R. H. BUBE. Letter in *J. Chem. Phys.*, **19**, 985 (*July*, 1951).

The previous results of Kröger, Hellingman and Smit [Abstr. 3258 (1948)] are confirmed for inclusion of Cl in ZnS–Cu and also the correlation between luminescence and position of Cu impurity in the crystal lattice. G. F. J. GARLICK

535.371

7763. Test for fluorescence. A. DI BERNARDO AND J. E. TYLER. Letter in *J. Opt. Soc. Amer.*, **41**, 558–9 (*Aug.*, 1951).

An attachment for use with the G.E. spectrophotometer is described. A split field arrangement permits the direct comparison test of pigments for presence of fluorescence produced by exciting monochromatic light. G. F. J. GARLICK

535.371 : 539.13

7764. Fundamental polarization of photoluminescence and torsional vibrations of molecules. A. JABLOŃSKI. *Acta Phys. Polon.*, **10** (*No.* 3–4) 193–206 (1951).

Customary experimental methods determine only the pseudoprincipal polarization (p.p.p.), i.e. principal polarization diminished by torsional vibrations of molecules. An expression for p.p.p. is derived as function of the 3 principal transition probabilities of the virtual spatial electronic oscillator and the mean squares of angles of turn about the oscillator axes. Hence the standard deviation of angles of turn and frequency and moments of torsional vibrations can be deduced. J. JACOBS

535.371 : 539.234

7765. Transparent luminescent films. F. J. STUDER, D. A. CUSANO AND A. H. YOUNG. Letter in *J. Opt. Soc. Amer.*, **41**, 559 (*Aug.*, 1951).

Transparent luminescent coatings of zinc sulphide have been obtained either by passing H_2S over heated zinc (plus activator salt) and depositing the ZnS formed on a plate or by heating evaporated layers of zinc fluoride at 500°C in a stream of H_2S for a few minutes. G. F. J. GARLICK

535.372

7766. Fine structure in the emission spectrum of manganese activated zinc silicate. C. C. VLAM. Letter in *J. Opt. Soc. Amer.*, **41**, 558 (*Aug.*, 1951).

Studies of the luminescence spectrum of a Zn_2SiO_4–Mn phosphor at 15°K reveal fine structure in the green emission band with a strong line at 5 155 Å. G. F. J. GARLICK

535.375.5

7767. On the Raman spectrum of diphenylmethane. S. K. MUKERJI AND B. LAL. *Indian J. Phys.*, **25**, 53–5 (*Jan.*, 1951).

The Raman spectrum of diphenylmethane has been studied by using λ4358 as the exciting line, the substance has yielded 18 Raman lines, some of them being not recorded before. These lines are at 3 057(6), 2 914(3), 2 789(4), 1 610(6), 1 590(4), 1 425(2), 1 280(2), 1 180(2)bd, 1 026(6), 1 004(10), 813(4)diff., 740(4), 612(4), 550(2), 461(1), 280(2), 231(4) and 194(4) cm^{-1} respectively. The observed frequencies have been compared with those of diphenyl observed by previous authors, and it has been found that all the frequencies of diphenyl are also present in diphenylmethane. A.

535.375.5

7768. Low-frequency Raman lines in para-dichlorobenzene. H. NARAIN AND B. D. SAKSENA. *Indian J. Phys.*, **25**, 79–92 (*Feb.*, 1951).

The l.f. lines of para-dichlorobenzene have been studied in different orientations of the crystal which was in the form of a cylinder with the symmetry axis along the length of the cylinder. Raman spectra of the liquid and of a different specimen of solid para-dichlorobenzene have also been studied. A.

535.375.5

7769. Raman spectrum of apophyllite. P. S. NARAYANAN. Letter in *Curr. Sci.*, **20**, 94–5 (*April*, 1951).

The 19 lines observed in the Raman spectrum of apophyllite ($KFCa_4Si_8O_{20} . 8H_2O$) are tentatively assigned to their respective symmetry types.
W. R. ANGUS

535.375.5

7770. Investigations of the Raman spectrum of some aromatic monocrystals. A. FRUHLING. *Ann. Phys., Paris*, **6**, 401–80 (*May–June*, 1951) *In French.*

In benzene the rotational vibrations are active but do not couple with translational inactive ones. Lines at 63 and 105 cm^{-1} are due to pivoting about axes of inertia in the molecular plane. The existence of 2 molecules in each cell is deduced. At pressures above 700 atm, agreement with London's dispersion formula is reached. A centre of symmetry is established for diphenyl from internal rays. In crystals the polarization of these rays does not obey the Placzek theory. J. JACOBS

535.375.5 : 539.132

7771. The Raman spectrum of tetramethyldiborane: Apparatus for the production of Raman spectra at low temperatures. B. RICE, J. M. GONZALEZ BARREDO AND T. F. YOUNG. *J. Amer. Chem. Soc.*, **73**, 2306–7 (*May*, 1951).

An experimental procedure is described which

simplifies the production of Raman spectra at low temperatures and in the absence of air. The Raman spectrum of liquid tetramethyldiborane at a temperature below 0° was photographed. No Raman lines with frequencies characteristic of terminal boron–hydrogen stretching were observed. This fact is evidence for a hydrogen-bridge-type structure in the tetramethyldiborane molecule and constitutes further evidence for the bridge structure in diborane. In the frequency range characteristic of bridge-hydrogen stretching two lines exist, instead of the one strong one found in the spectrum of B_2H_6. A.

535.375.5 : 539.133

Raman spectrum of fluorine. *See Abstr.* 8110

535.375.55

7772. The Raman spectra of metallic nitrates and the structure of concentrated solutions of electrolytes. J.-P. Mathieu and M. Lounsbury. *Disc. Faraday Soc.*, *No.* 9, 196–207 (1951).

A comprehensive study of the Raman spectra of solutions of metallic nitrates at various concentrations shows that the NO_3^- ions experience some deformation as the concentration increases and that in concentrated solutions of most of them an equilibrium takes place between two forms of NO_3^-. The facts can be interpreted by assuming that the saturated solutions have a structure very similar to that of the hydrated crystals which are deposited from them. A.

535.375.56

7773. A note on the Raman spectra of CH_2Cl_2 and $CHCl_3$ in the vapour state. M. V. Rao. *Indian J. Phys.*, **25**, 61–4 (*Feb.*, 1951).

The Raman spectra of methylene chloride in the liquid state at 55°C and in vapour state at 60°C as well as those of chloroform in the liquid state at 90°C and in vapour state at 95°C have been investigated. It is observed that in both the cases some of the prominent lines undergo changes in the intensity and position with the changes from liquid to vapour state. In the case of chloroform the line 3 014 cm^{-1} seems to be weakened very much with the vaporization of the liquid. It is also suggested that the probability of inelastic scattering may be increased by action of an intermolecular field in the state of aggregation. A.

535.376

7774. Measurements of secondary-electron emission from common phosphors. W. A. White. *Overseas Res. Rep.* (*Dep. Sci. Industr. Res. Lond.*) 83/51 [*Off. Tech. Serv. Wash.*, *PB* 101420].

Naval Research Laboratory, Report 3661. Measurements were made on four phosphors over a range of primary-electron energy from 300 to 2 500 eV. A dynamic method employing pulse technique was used, in which the ratio of two transient-displacement currents determines the secondary-emission ratio. The success of the method is said to be attributable to a technique devised for establishing a stable initial-reference surface potential. For the phosphors tested, maximum secondary-emission ratio ranges between 2·6 and 3·9 and occurs in each case at a primary energy in the range 500 to 1 000 eV. The variation of the secondary-emission ratio as a function of position over the surface was investigated, using a 5 mm spot dia., and found to be completely negligible except at the extreme edge of the screen.

535.376

7775. Energy storage and light stimulated phosphorescence in activated NaCl crystals induced by gamma-rays. H. Kallmann and M. Furst. Letter in *Phys. Rev.*, **83**, 674 (*Aug.* 1, 1951).

An attempt is made to relate the phenomena of phosphorescence, stimulation and energy storage described previously [Abstr. 6892 (1951)] to electron trapping in colour centres and in shallow traps. The latter are associated with the impurity activator.

G. F. J. Garlick

535.376 : 535.89

7776. Research on high intensity phosphor light source (H. W. Leverenz) **and Studies and investigations in connection with the development of a new light source consisting of a phosphor rod irradiated by high voltage electrons.** *Overseas Res. Rep.* (*Dep. Sci. Industr. Res. Lond.*) 132/51 [*Off. Tech. Serv. Wash.*, *PB* 3347; *PB* 3342].

Experiments are described in which long transparent phosphor crystals were excited along their lengths and viewed end-on to see whether they could be used as high-intensity, voice-modulated signalling devices. Transparent acicular willemite crystals were used. Excitation by 2 537 Å u.v. and by 40 kV cathode rays is said to have given an end-brightness of the crystal $> 100\times$ the side-brightness. The light output from the end of the crystal increased linearly with increasing excited length up to about 1 cm. It is not known why the linear cumulative effect tapered off beyond the mid-point of the crystal. A second report is included which describes the preparation of crystals to test the hypothesis that needle-shaped phosphor crystals irradiated transversely would become an intense light source capable of modulation. Needles of activated willemite were prepared of sufficient size to test the hypothesis which is said to have proved incorrect. Most of the report is devoted to the preparation of fine-grained plates for the screens of image tubes.

535.376 : 537.533.74

7777. Electron penetration and scattering in phosphors. L. R. Koller and E. D. Alden. Letter in *Phys. Rev.*, **83**, 684 (*Aug.* 1, 1951).

The depths of penetration of 2–40 kV electrons in ZnS films of 0·1–0·45 μ, were deduced from oscillograph traces of brightness against beam voltage. An expression is obtained for beam energy as a function of depth of penetration. J. A. Franks

535.39

7778. Low-reflection films produced on glass in a liquid fluosilicic acid bath. S. M. Thomsen. *RCA Rev.*, **12**, 143–9 (*March*, 1951).

The low-reflection film known as "Magicote C" is produced on glass surfaces by the chemical attack of a liquid in which the glass is immersed. The liquid is a modified aqueous fluosilicic acid solution of controlled composition. This is a low-cost process, capable of handling large sheets of glass. The reflection of white light is reduced to 5% of that of the original unprocessed glass. Best suited for filming

by this method are the crown glasses, including window glass and polished plate glass. A.

535.41 : 535.822.9

7779. An interference filter for use as a phase plate in "phase contrast." C. DUFOUR AND M. LOCQUIN. *C.R. Acad. Sci., Paris*, **232**, 2087–9 (*June* 4, 1951) *In French.*

A dielectric interference filter, whose phase retardation varies rapidly with wavelength, can be used as a phase plate. By illuminating with light of two wavelengths, details of the specimen are seen as variations of colour. R. W. FISH

535.417

7780. New techniques in optical interferometry. I–V. H. KUHN. *Rep. Phys. Soc. Progr. Phys.*, **14**, 64–94 (1951).

Part I deals with optical properties of thin films. Multiple dielectric films, deposited on glass, can have reflection coefficients up to 0·9 for visible light, and much higher values can be reached for silver films. The intensity distribution in the reflected and transmitted light in multiple beam interference is discussed and applied to interference filters. "Frustrated total reflection" filters and polarization filters are briefly described. Part II deals with recent methods of using Fabry–Perot etalons. The theory and practical performance of the double etalon, the photoelectric method of recording etalon fringes and the use of etalons in solar spectroscopy are described. Part III deals with standards and testing methods, pure isotope light sources, testing of gauges, etc., and gives a description of the "wavefront shearing interferometer." Part IV deals with the interferometric study of surfaces, and Part V with recent modifications of the classical methods of interference refractometry and with the application of interferometers to the study of gas flow at high speeds. A.

535.417

7781. The shape of reflected interference fringes from interferometers coated with thin metal films. J. HOLDEN. *J. Opt. Soc. Amer.*, **41**, 504–10 (*Aug.*, 1951).

A type of optical observation for the study of very thin metal films is reported. The shape or intensity distribution of reflected interference fringes from an interferometer which involves the thin film as its front or incident surface is observed to undergo a cyclic change as the metal film increases in mass per unit area. The effect is studied throughout the visible spectrum for the metals Ag, Au, Al, Cu and Cr, evaporated in such a manner as to form films of gradually increasing mass per unit area up to an equivalent thickness of 400 Å. The effect is sensitive to the rate of formation of the films, to effects of increased temperature of the substrate, and correlates with recent electron microscope observations on the stable form of thin films of these metals. Brief mention is made of the practical applications of the several types of reflection fringe intensity distributions which are possible, to current investigations of the mechanisms of slip and twinning in metal crystals. A.

535.417 : 531.715.1

Interferometric calibration of precision screws and control of ruling engines. *See Abstr.* 7576

535.42 : 535.317.1

7782. The concept of partial coherence in optics. H. H. HOPKINS. *Proc. Roy. Soc. A*, **208**, 263–7 (*Aug.* 22, 1951).

It is shown that a "phase coherence factor" may be defined in a manner which leads, without recourse to explicit statistical analysis, to the theorems established by van Cittert and Zernike for analogous factors. An invalid approximation made in their calculations of the phase-coherence factor for a plane illuminated directly by a source is corrected. The new treatment is applied to the theory of Young's experiment, the stellar interferometer, and illumination in the microscope. The phase-coherence factor defined here enables a general theory of the formation of optical images to be formulated. Further, it is shown that the diameter of the area of coherence on a plane illuminated by a source of angular radius α is given by $d = (0{\cdot}16\,\lambda)/(N \sin \alpha)$, where N is the refractive index of the intervening medium. A.

535.422

7783. Measurements of the precision of longitudinal positioning. B. DOSSIER, P. JACQUINOT, M. MARÉCHAL AND G. PIEUCHARD. Letter in *J. Phys. Radium*, **12**, 565–7 (*April*, 1951) *In French.*

Practical measurements of the increased accuracy of focusing obtained by placing diaphragms over the objective [see Abstr. 5326 (1951)] show that the sensitivity may be increased by a factor up to $\times 6{\cdot}7$. R. W. FISH

535.43

7784. Light scattering in gases. S. PARTHASARATHY. Note in *Indian J. Phys.*, **25**, 22–4 (*Jan.*, 1951).

Gives depolarization factors for a large number of gases after due correction of the earlier values obtained by the author, for the convergence of the lens used. A.

535.434

7785. The scattering of light by liquid droplets of different refractive indices. M. M. PARANJPE AND M. V. SHINGRE. *J. Univ. Bombay*, **19**, 1–6 (*March*, 1951).

The scattering factor for chloroform, benzene, aniline and carbon disulphide was measured every 5° between 0° and 180° and found to agree fairly well with that calculated on Mie's theory. N. CORCORAN

535.511 : 522.56

Interference polarizing filters. *See Abstr.* 7453–4

535.543

7786. On the sensitive color of chromatic polarization. H. KUBOTA, T. ARA AND H. SAITO. *J. Opt. Soc. Amer.*, **41**, 537–46 (*Aug.*, 1951).

In the phenomenon called "chromatic polarization," which is shown by a crystal plate placed between Nicol prisms, viewed with white light, it has long been known that there are sensitive colours in the case of parallel as well as crossed Nicols. However, it has not been noticed that the former has greater sensitivity than the latter. It is shown, as the result of a colorimetric analysis, that the sensitivity of the former is more than twice as great as that of the latter in the case of first-order interference colours. It was also

found that, to get maximum sensitivity, the sensitive colour plate must have a suitable retardation, dependent on the temperature of the light source. Combining these facts, the authors have found a simple but very sensitive method of examining quarter-wavelength plates. A.

535.545

7787. Effect of a Gaussian distribution on flow birefringence. H. A. SCHERAGA. Letter in *J. Chem. Phys.*, **19**, 983–4 (*July*, 1951).

Considers the effects of a Gaussian distribution of particle size, the particles being assumed to be rigid ellipsoids having the same optical factor.

H. H. HOPKINS

535.611

7788. Color tolerance specifications for paint. T. F. BOYD. *J. Opt. Soc. Amer.*, **41**, 552–7 (*Aug.*, 1951).

As a basis for preparing colour specifications for paints, a study was made of observers and conditions in relation to grading colour differences and selecting tolerances for a green paint. Simple colour difference formulae gave as good or better correlation with visual observations as complicated formulae. There was no appreciable difference between results under north daylight and an artificial source of north daylight. Colour requirement limits determined by inexperienced observers were about the same order as for experienced observers. The study indicates that in many cases it may not be necessary to prepare a very large number of colours in the preparation of colour specifications. Time was saved in the present study by the use of one-dimensional colour series to determine colour requirement limits. A.

535.621.1 : 612.843.31

7789. A psychophysical study of white. I. Neutral adaptation. L. M. HURVICH AND D. JAMESON. *J. Opt. Soc. Amer.*, **41**, 521–7 (*Aug.*, 1951).

A discussion is presented of the concept white as it is used to describe properties of light, properties of objects and properties of sensation. The concept can have both practical and theoretical significance only when the psychophysical functions relating the sensation white to the stimulus variables are known. An apparatus and method used to obtain such functions are described. Data are presented for 3 observers, for a neutral state of adaptation, dark surround, 11·7° test field, and a one-second stimulus duration. White threshold contours are shown which relate the approximate colour temperature of the test stimulus and the luminance required to evoke a sensation of absolute white. These contours form the lower boundary of a white sensation area, in which all colour temperature-luminance combinations evoke an absolute white sensation for the given observers and experimental conditions. A.

535.621.1 : 612.843.31

7790. A psychophysical study of white. II. Neutral adaptation. Area and duration as variants. D. JAMESON AND L. M. HURVICH. *J. Opt. Soc. Amer.*, **41**, 528–36 (*Aug.*, 1951).

Experimental data are presented which provide a psychophysical specification of white in terms of colour temperature, luminance, stimulus area and duration. White threshold contours for 3 observers were obtained for 5 different angular sizes of test field: 2·0°, 5·8°, 11·7°, 23·4° and 46·8° subtended at the eye, and for 2 exposure durations: 1 sec and 5 sec. The luminance range extended from 3 mL to 3 000 mL. All results were obtained for a neutral state of adaptation. The specific variation in the white threshold with changes in stimulus area is itself shown to be a function of the colour temperature of the test stimulus. The major effect of an increase in stimulus duration is an increase in the range of colour temperatures which appear white at a given level of luminance. Sources of inter-observer differences are discussed, and the variability of the measurements is shown to be lawfully related to the luminance level. A.

535.65

7791. American standard methods of measuring and specifying color. *J. Opt. Soc. Amer.*, **41**, 431–9 (*July*, 1951).

These have been issued under the code designations of American Standard Methods Z58.7.1-1951, Z58.7.2-1951 and Z58.7.3-1951. They have been prepared by a committee under F. W. Sears, with the assistance of representatives of some 25 co-operating organizations, including the Optical Society of America. The *Journal* has previously published some of the ASA report which appears here, as portions of the Colorimetry Committee Report [*J. Opt. Soc. Amer.*, **34**, 633 (1944)] and in papers by D. B. Judd and others [*J. Opt. Soc. Amer.*, **33**, 359 (1933)], especially the tristimulus values, trichromatic co-ordinates, chromaticity diagram, etc. The additional prestige and confirmation of acceptability of these data by their incorporation in the ASA publication does not mean that their designation as the ICI standard observer, ICI source C, ICI tristimulus values, etc., is no longer desirable. A.

535.65 : 621.327.43

7792. Colorimetry of fluorescent lamps. J. GÉNARD. *Rev. Tech. Luxemb.*, **43**, 62–9 (*April–June*, 1951) *In French.*

Describes the basis of colorimetric measurement and its application to fluorescent lamps. The use of spectrophotometric data for the calculation of the colour characteristics of a source, or of the light reflected from a coloured surface of known spectral reflection curve is explained. It is pointed out that the colour co-ordinates of a lamp provides no criterion of its colour-rendering properties.

J. W. T. WALSH (R)

535.65 : 621.383 : 621.317.39

7793. Effect of variations of intensity and voltage on the accuracy of colour measurement. A. LENNARTZ. *Funk u. Ton*, **5**, 316–21 (*June*, 1951) *In German.*

In a colour-meter depending upon a balance between the currents passed by two photocells, one red- and the other blue-sensitive, the readings obtained depend to some extent on the voltage applied and on the illumination level at the cells. This effect is discussed mathematically for both photo-emissive and photovoltaic cells and methods of minimizing the inaccuracies caused are suggested. J. W. T. WALSH

535.651 : 535.247.7 : 621.317.39 : 621.383

7794. Circuit for the Barnes color meter. P. H. DOWLING. Letter in *Rev. Sci. Instrum.*, **22**, 538–9 (*July*, 1951). See Abstr. 1048 (1946).

535.66 : 539.13

7795. Coloured addition compounds. F. CRAMER. Letter in *Naturwissenschaften*, **38** (*No.* 8) 188 (1951) *In German.*

The absorption maxima of the incorporated iodine complexes are shifted to longer wavelengths owing to strong fields set up inside the molecular empty spaces. J. JACOBS

535.8 : 526.93 : 531.74

Electro-optical measurement of angles by a photometric method. *See Abstr.* 7577

535.822.9

7796. A reflecting microscope of 1·3 numerical aperture. K. P. NORRIS AND M. H. F. WILKINS. *Disc. Faraday Soc., No.* 9, 360–3 (1950).

The construction and use of a focusing polychromatic u.v. microscope objective of 1·3 numerical aperture, formed by adding a fused quartz amici lens to a reflecting objective, is described. A.

535.833

7797. The astigmatic correction of telescopes. R. S. LONGHURST. *Proc. Phys. Soc., Lond. B*, **64**, 713–17 (*Aug.*, 1951).

It is shown theoretically that if a telescope has positive field curvature the best possible image on the Gaussian plane is obtained by making the tangential field flat. A.

535.89 : 545.822

7798. Cyanogen rarefaction using solid CO_2. W. J. WARK. Letter in *J. Opt. Soc. Amer.*, **41**, 482 (*July*, 1951).

Demonstrates how CN bands, often objectionable when spectrographic analysis with carbon electrodes in air is attempted, can be eliminated by the use of a simple cell, surrounding the arc gap, in which dry ice is inserted. The evaporated CO_2 displaces the air in the cell before the arc discharge is initiated.

J. D. CRAGGS

HEAT 536

536.2 : 536.46

7799. Contribution to the graphical study of thermally variable systems. J. JACQ. *C.R. Acad. Sci., Paris*, **232**, 2292–5 (*June* 18, 1951) *In French.*

See Abstr. 5345 (1951). Extension of case previously considered to more complex boundaries.

F. E. HOARE

536.2.02

7800. A problem in radial heat flow. H. GOLDENBERG. *Brit. J. Appl. Phys.*, **2**, 233–7 (*Aug.*, 1951).

The heat equation is solved for the case of constant heat/(unit volume)/(unit time), generated in a spherical region of a homogeneous infinite medium. Curves are drawn showing the transient temperature: (1) at the centre of the spherical region: (2) at the surface of the spherical region; and (3) at a distance from the centre of twice the radius. The transient temperature at any point of the medium may readily be calculated from the expressions derived, as, apart from material constants, these expressions involve only tabulated functions. A.

536.21

7801. A method for the calculation of heat transfer in solids with temperature-dependent properties. R. PLUNKETT. *Trans Amer. Soc. Mech. Engrs*, **73**, 605–8 (*July*, 1951).

The problem of heat transfer in a solid, whose conductivity and specific heat depend on the temperature, is converted by a simple change of variable to one in which the conductivity may be held constant, and only the specific-heat term varies with temperature in a way which depends upon the variation of both parameters. The method is illustrated by application to a problem previously solved by Dusinberre in a different way. The effect on the final solution of different finite approximations to the derivatives is also discussed. A.

536.21 : 536.48

7802. The thermal conductivities of some dielectric solids at low temperatures (experimental). R. BERMAN. *Proc. Roy. Soc. A*, **208**, 90–108 (*Aug.* 7, 1951).

An apparatus is described in which the thermal conductivity of solids can be determined at any temperature between 2 and 90°K. Several glasses and dielectric crystals have been measured. It had previously been found that at high temperatures the conductivity of glasses is proportional to the specific heat, but at low temperatures it falls off more slowly than the specific heat. The present experiments show that there is a temperature region in which the conductivity is nearly independent of temperature. A similar variation of conductivity is found for the thermo-plastic Perspex. The effect of lattice defects in crystals was studied by measuring the thermal conductivity of a quartz crystal before and after successive periods of neutron irradiation. After prolonged irradiation the conductivity approached, in both magnitude and temperature variation, that of quartz glass. Subsequent heating produced a substantial recovery in the conductivity. The results on both glasses and on crystals can be explained by the theory developed by Klemens (1951). Further measurements made on a corundum crystal confirm the importance of the "Umklapp" processes, postulated by Peierls, in causing thermal resistance. A.

536.21 : 536.48

7803. The thermal conductivity of dielectric solids at low temperatures (theoretical). P. G. KLEMENS. *Proc. Roy. Soc. A*, **208**, 108–33 (*Aug.* 7, 1951).

The statistical equilibrium of phonons in the presence of a temperature gradient is investigated, and a general formula for the thermal conductivity of dielectric solids is obtained. This is applied to quartz glass, giving good agreement with values observed by Berman (preceding Abstr.) and to crystals. Comparison between theory and experiment is made for alkali-halides and quartz, and conclusions are drawn about the defects in neutron-irradiated quartz. A.

536.23

7804. Measurements of the heat conductivity of nitrogen–carbon dioxide mixtures. F. G. KEYES. *Trans Amer. Soc. Mech. Engrs*, **73**, 597–603 (*July*, 1951).

Measurements have been made of the heat conductivity at 0, 50, and 150° C for three mixtures of nitrogen and carbon dioxide. At 50° C the conductivity of the pure compounds was measured over a range of pressure for constituents and mixtures. A discussion of the pressure effects is given. A.

536.242

7805. A study of the mechanism of boiling heat transfer. W. M. ROHSENOW AND J. A. CLARK. *Trans Amer. Soc. Mech. Engrs*, **73**, 609–20 (*July*, 1951).

An analysis of the heat quantity required to form a vapour bubble in a liquid is presented. High-speed motion pictures of boiling heat transfer in forced convection showing bubbles departing from a heated surface are analysed and the net heat transferred to the bubbles is compared with the total heat transferred from the heated surface. It is found that the heat transferred to the moving liquid by the condensation of the bubbles is a negligible part of the total convective heat transfer. Therefore it is proposed that the high rate of heat transfer associated with surface boiling in a subcooled liquid is due primarily to the violent agitation of the quiescent layers of liquid adjacent to the heated surface resulting from the motion of vapour bubbles being generated there. A.

536.413

7806. Phase transition in bariumdicalcium-propionate. S. SEKI, M. MOMOTANI AND K. NAKATSU. Letter in *J. Chem. Phys.*, **19**, 1061–2 (*Aug.*, 1951).

536.413

7807. Volume-temperature relationships for the room temperature transition in Teflon. F. A. QUINN, JR, D. E. ROBERTS AND R. N. WORK. Letter in *J. Appl. Phys.*, **22**, 1085–6 (*Aug.*, 1951).

536.413 : 536.421.1 : 548.7

7808. On linear expansion coefficient and melting point of metals. G. BONFIGIOLI AND G. MONTALENTI. Letter in *J. Appl. Phys.*, **22**, 1089–90 (*Aug.*, 1951).

See Abstr. 8697 (1950). The law λT_m = constant is here examined, and is shown to be roughly followed by groups of metals of the same symmetry class; e.g. $\lambda T_m = 2{\cdot}43 \pm 0{\cdot}44$ for eight b.c.c. metals. If true, this relation would have the physical meaning that a given crystalline network melts when the total expansion reaches a given figure, which is higher the higher the symmetry. The authors discuss whether experimental and other causes may be responsible for the agreement being only approximate.

536.421.4 : 532.782

7809. Supercooling of liquid phosphorus. J. H. HILDEBRAND AND G. J. ROTARIU. *J. Amer. Chem. Soc.*, 73, 2524–5 (*June*, 1951).

Phosphorus can be kept in liquid form indefinitely at room temperature, despite the fact that crystallization involves only minimal changes in entropy (R cal/deg) density and number of nearest neighbours. The authors succeeded in cooling drops of 1 mm diameter or less to $-71{\cdot}3°$, which is $115{\cdot}6°$ below its melting-point. There was no evidence of glass formation. This suggests that it is not altogether realistic to regard the structure of the liquid as that of a quasi-solid lattice with occasional holes. A.

536.422.1

7810. A study of mass transfer rates from the solid to the gas phase. A. C. PLÈWES AND J. KLASSEN. *Canad. J. Techn.*, **29**, 322–31 (*July*, 1951).

Five pure solids have been vaporized in turbulent air streams, and the results indicate that the evaporation processes may be correlated by the Sherwood–Gilliland relationship for the vaporization of liquids from moving films into turbulent air streams: $d'/x = 0{\cdot}023\ Re^{0{\cdot}83}\ Sc^{0{\cdot}44}$. This work indicates that the mechanism for mass transfer in gas-solid systems is analogous to that existing for liquid-gas systems. The results also offer a convenient method of estimating rates of sublimation and condensation in solid-gas systems. A.

536.424.1

7811. The effect of particle size and deuterium substitution on the λ-point in ammonium chloride. D. G. THOMAS AND L. A. K. STAVELEY. *J. Chem. Soc.* (1951) 1420–5 (*June*).

The final stages of the λ-points in ammonium chloride, monodeuteroammonium chloride, and trideuterammonium chloride have been examined dilatometrically with temperature control to $\sim \pm 0{\cdot}002°$. The transitions in the partly deuterated salts, like that in ammonium chloride, reach completion almost isothermally, and hysteresis is associated with the nearly vertical part of the volume-temperature curves. This is in contrast to the transition in tetradeuterammonium chloride which is known to be continuous throughout and free from hysteresis. The salts examined were prepared by reaction of equimolecular quantities of the component gases. The products were found by electron-microscope examination to consist of very small crystals. The hysteresis loop for these small crystals of ammonium chloride was appreciably narrower than that for larger crystals, but the mean transition temperature was almost unchanged. A.

536.44

7812. Contribution to the theory of critical phenomena. B. H. ZIMM. *J. Chem. Phys.*, **19**, 1019–23 (*Aug.*, 1951).

If one considers the critical point between the liquid and gaseous phases, it may be shown that the "principle of superposition" leads to the result that the critical point is a singularity in the isotherm of fugacity or pressure against density. At this singularity the derivatives of every order of the fugacity or pressure with respect to the density are zero, not only the first two derivatives as in the van der Waals theory. It is postulated that these relations are true despite the uncertain nature of the superposition approximation. If the critical point is such a singular point, it can be shown that Mayer's theory of critical phenomena leads quite reasonably to a single characteristic temperature instead of to two separate temperatures for the vanishing of the slope of the isotherm

and for the appearance of a surface tension. Experimental observations on the anomalous shape of the isotherms near the critical point are in accord with the theory. A.

536.44

7813. Note on the theory of critical phenomena. J. E. Mayer. *J. Chem. Phys.*, **19**, 1024–6 (*Aug.*, 1951).

Zimm's theoretical considerations (preceding Abstr.) are compared with the earlier conclusion of this author. Some of the consequences which must be drawn if one is not to accept Zimm's conclusions are pointed out. It appears that the latter are at least as plausible as this author's earlier hypotheses. A.

536.46

7814. Measurement of velocity and pressure of gases in rocket flames by spectroscopic methods. F. P. Bundy, H. M. Strong and A. B. Gregg. *J. Appl. Phys.*, **22**, 1069–77 (*Aug.*, 1951).

A method for measuring the gas flow velocity in hot high-velocity exhaust flames is described. This method is based on the Doppler shift of wavelength of the Na or Li spectral radiation from the flame when viewed at different angles relative to the flame axis. The same apparatus may be used to measure the gas pressure from the pressure shift of wavelength of the Na radiation. A Fabry–Perot interferometer and camera assembly was used to determine the small shift in wavelengths. It was concluded that the absolute accuracy of any one velocity measurement by this method is about $\pm 1 \cdot 5 \times 10^4$ cm/sec, while that of any one pressure measurement is about $\pm 0 \cdot 3$ atmospheres. The method is therefore applicable to flames of very high velocity and to pressures of at least a few atmospheres. A.

536.462

7815. The temperature distribution along a radiating gas stream in which heat is being liberated by a chemical reaction. M. W. Thring. *Proc. Roy. Soc. A*, **208**, 247–62 (*Aug.* 22, 1951).

As a first approximation, to calculate the variation of flame temperature (Y) with distance (X) along a slowly burning flame, the flame is taken to consist of a central stream or jet of fuel which enters at the temperature (T) of the heat sink and entrains combustion air at a rate constant with respect to X. This entrained air is assumed to react rapidly with the fuel stream and the products of the reactions remain in the fuel stream, so that the temperature (Y) of the latter rises at a rate dY/dX which falls off as the heat capacity of this stream increases. When there is no heat loss from the fuel jet the temperature/distance curve is shown to be a rectangular hyperbola. The curvature at any point of the hyperbola increases as (q), the ratio of the heat capacity of the initial fuel stream to that of the final combustion products, decreases. In other cases heat transfer is supposed to take place by convection ($\propto [Y - T]$) or radiation ($\propto [Y^4 - T^4]$) between the fuel jet and the heat sink with a heat-transfer coefficient which is assumed to be constant for a cylindrical flame and proportional to distance from the inlet for a conical flame. The temperature/distance relationships are considered for these cases. A.

536.48

7816. Two fluid theory of liquid helium below 1°K. S. Nakajima and M. Shimizu. *Progr. Theor. Phys.*, **6**, 122–5 (*Jan.–Feb.*, 1951). See Abstr. 2627 (1951).

536.48

7817. Thermal conductivity of liquid helium. I. C. Grenier. *Phys. Rev.*, **81**, 598–603 (*Aug.* 1, 1951).

Direct measurements have been made of the thermal conductivity of liquid He over the temperature range from its normal boiling-point at 4·2°K to a temperature within a few hundredths of a degree of the λ-point. The results show that the thermal conductivity decreases linearly with temperature from a value of $6 \cdot 5 \times 10^{-5}$ cal/deg cm sec at 4·2°K to about $4 \cdot 5 \times 10^{-5}$ cal/deg cm sec close to the λ-point. No large deviation from linearity can be detected in the heat conductivity until about 0·2 degree from the transition temperature of 2·18°K. A.

536.48

7818. Preparation of extremely pure helium gas. M. A. Biondi. Letter in *Rev. Sci. Instrum.*, **22**, 535–6 (*July*, 1951).

Superflow through a capillary below the λ-point is used. Constructional details and vacuum technique are described.

536.483

7819. A constant-level control for liquid nitrogen. M. Lounsbury. Letter in *Rev. Sci. Instrum.*, **22**, 533 (*July*, 1951).

536.51

7820. The gas thermometer of the Institute of Meteorology, University of Helsinki. E. Tilvis. *Ann. Acad. Sci. Fennicae, Ser. A*1, *No.* 95, 14 *pp.* (1951).

Covers the range −80 to 40°c and consists of a Jena glass envelope enclosing two masses of H gas, one of approx. 297 cm³ kept at constant volume and separated by a Hg U-tube, the other of 16 cm³ kept at constant temp., both gas masses maintained at equal pressure (750 mm Hg approx. at 0°c). Full details, with drawings, of the thermometer, and associated thermostats with electronic control system are given. A formula for the calculation of the temperature, including correction for the thermal expansion of the glass, is derived. The correction for change in internal pressure is negligible. A curve of mean error (< 0·1°c) against temp. for the range of operation is given. S. Weintrou

536.53

7821. The calibration of platinum resistance thermometers in the temperature range 11° to 90°K. J. M. Lo and J. A. Morrison. *Canad. J. Phys.*, **29**, 142–5 (*March*, 1951).

A set of 6 Pt resistance thermometers of a form suitable for low-temperature calorimetry has been made and calibrated in the region 11° to 90°K by intercomparison with a similar thermometer calibrated at the National Bureau of Standards. Above 90°K calibration has been made on the International Temperature Scale. Using the intercomparison data it has been possible to derive a method whereby for these thermometers the scale for the region 20° to 90°K may be found to within 0·002°c by means of fixed points. The method applies a "Z function"

the type used at the National Bureau of Standards, plus a corrective term which depends upon the resistance of the thermometer at the boiling-point of hydrogen and upon the normal constants which are determined for the International Temperature Scale above 90°K. A.

536.531

7822. A modification in the construction of calorimetric resistance thermometers. F. J. GITTINGS. *J. Sci. Instrum.*, **28**, 238 (*Aug.*, 1951).

536.581.3

7823. A low temperature thermostat. R. HAUL AND J. J. THERON. *J. Sci. Instrum.*, **28**, 236–7 (*Aug.*, 1951).

A low temperature thermostat for the region −20°C to −78°C is described, which uses dry ice as refrigerant. A platinum resistance thermometer in conjunction with an electronic relay serves as a temperature-sensitive element. The instrument is capable of maintaining any given temperature in the above range within an accuracy of ±0·15°C for any desired time, with better regulation (±0·05°C) over periods of hours. A.

536.62 : 541.11

7824. A new calorimetric method. A. BUZZELL AND J. M. STURTEVANT. *J. Amer. Chem. Soc.*, **73**, 2454–8 (*June*, 1951).

An apparatus suitable for the measurement of the heat effects of slow chemical reactions in aqueous solutions is described. Twin calorimeters serve as a thermal balance to compare the chemical energy evolved or absorbed with automatically adjusted electrical energy, and analogue computers are used to evaluate the electrical energy. The functioning of the apparatus is illustrated by determinations of the heat of the inactivation of pepsin. A.

536.662

7825. The heats of combustion and formation of titanium nitride (TiN) and titanium carbide (TiC). G. L. HUMPHREY. *J. Amer. Chem. Soc.*, **73**, 2261–3 (*May*, 1951).

The standard heats of formation, calculated from the combustion data, are: TiN, $-80{\cdot}4_7 \pm 0{\cdot}2_7$; TiC, $-43{\cdot}8_5 \pm 0{\cdot}3_9$ kcal/mole. Free energies of formation also are listed. A.

536.662

7826. Heat of combustion and formation of cyanogen. J. W. KNOWLTON AND E. J. PROSEN. *J. Res. Nat. Bur. Stand.*, **46**, 489–95 (*June*, 1951).

536.666

7827. The heat of dissociation of fluorine. R. N. DOESCHER. Letter in *J. Chem. Phys.*, **19**, 1070–1 (*Aug.*, 1951).

THERMODYNAMICS 536.7/.8

536.7 : 538.63 : 538.66

7828. Thermodynamics of thermomagnetic and galvanomagnetic effects. P. MAZUR AND I. PRIGOGINE. *J. Phys. Radium*, **12**, 616–20 (*May*, 1951) *In French.*

Onsager's relations for irreversible processes are applied to the study of thermomagnetic and galvanomagnetic effects. The case of an isotropic medium in the absence of a magnetic field is considered. Fourteen effects, transverse and longitudinal, are calculated and expressed in terms of only six independent coefficients. Eight general relations between the different effects are indicated. F. E. HOARE

536.79 : 530.162

Remarks on the entropy constant and the third law of thermodynamics. *See Abstr.* 7570

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.221

7829. Image formation by electrographic means. B. BARSHCHEVSKIĬ AND V. LAVRENCHIK. Letter in *J. Tech. Phys., USSR*, **20**, 1273–4 (*Oct.*, 1950) *In Russian.*

A latent image of a conductor may be formed on an insulator such as S or Perspex (not glass or ebonite) if they are placed in contact and the conductor is charged to $\lessapprox 5$ kV. The image may be made visible by dusting with powdered resin or lycopodium powder; if resin is used, the image may be "fixed" by gentle warming. J. C. E. JENNINGS

537.221

7830. Powder patterns produced with alternating potentials. L. BERGMANN. *Z. Phys.*, **129** (*No.* 6) 611–18 (1951) *In German.*

The "finger-effect" or "strobanæsthesia" [see *Phys. Z.*, **31**, 623–5 (*July*, 1931)] is used to produce lycopodium or other powder patterns on plates which are connected to an alternating potential and the frequency of supply is determined from the patterns. By using a periodically interrupted d.c. potential it is shown that the powder becomes electrically charged by friction when it is moved over the plate by the finger, and thus, e.g. for a 50 c/s supply, 50 and not 100, powder heaps are produced per sec. Red lead powder and sulphur blossom, which are + and − resp., give red and yellow coloured patterns resp., but the best colour contrast is obtained by using a mixture of both with lycopodium. Patterns can be produced, by suitable arrangement, on rubber, plastics and paper in addition to lacquered and anodized metal plates. 4–6 V is sufficient to produce clear patterns, but the higher the potential, i.e. the thinner the insulating layer between the finger and the plate, the sharper and clearer the patterns. Using plates rotating at known speeds the frequency of supply can be determined directly from the number of striations in the pattern. In place of the finger, a wiping contact, a suitable form of which made from felt and metal-foil is described and illustrated, can be used and this gives very sharply defined striations. Several photographs of patterns for the different powders and for various frequencies up to 1 000 c/s are given. S. WEINTROUB

537.221 : 537.311.33

The work function of germanium. *See Abstr.* 7883

537.224 : 666.1 : 621.319.4

7831. Time relation of the h.v. polarization in heated glass. N. S. Novosiltsev and L. A. Kukoz. *J. Exp. Theor. Phys.*, **20**, 734–7 (*Aug.*, 1950) *In Russian.*

The discharge of a capacitor with heated glass as dielectric does not follow the exponential law, and RC loses its sense as time-constant. In a special case (glass No. 23) the process determining the h.v. polarization was sufficiently rapid to approach an exponential law. The capacitance of capacitors with hot glass as dielectric is then large and hardly varies during the process. The magnitude of the capacitance is only determined by size of electrodes and is independent of thickness of glass layer. B. F. KRAUS

537.226

7832. On the paper "On Onsager's theory of polarization of dipole liquids." V. I. Odelevskiĭ. *J. Tech. Phys.*, **20**, 1511–12 (*Dec.*, 1950) *In Russian.*

The author refers to his own earlier paper [Abstr. 3138 (1950)] to correct an error due to use of the expression of the molecular energy in the form $u = -(\vec{E_p}, \vec{m})$ (where $\vec{E_p}$ polarizing field, $\vec{m}$ total moment of the molecule) which is suitable only for the case of a rigid dipole and a constant polarizing field. This error is attributed to the manner in which the expression is derived in Onsager's original paper. A better derivation of the formula is given yielding the same results for the elastic polarization energy and free energy of the molecule as Onsager's original calculation [*J. Amer. Chem. Soc.*, **58**, 1986 (1936)].

B. F. KRAUS

537.226 : 548.0

7833. On the effective field strength in cubic crystals. W. Heywang. Note in *Z. Naturforsch*, **6a**, 219–20 (*April*, 1951) *In German.*

537.226.1

7834. On the static dielectric constant of dipolar solids. J. H. Simpson. *Canad. J. Phys.*, **29**, 163–73 (*March*, 1951).

An application of Fröhlich's general formula for the static dielectric constant is made to a material having a cubic arrangement of dipolar molecules, each of which has two equilibrium positions 180° apart and ordering forces of the short-range type which tend to make nearest neighbours antiparallel. It is shown that such a model cannot lead to a sharp transition in dielectric constant unless changes in lattice dimensions occur. Qualitative comparison with certain experimental results is made. A.

537.226.1 : 537.228.4 : 538.612

7835. The phenomena of molecular orientation in polar liquids and their solutions. II. Further development of the theory of dipole coupling in polar liquids. A. Piekara. *Acta Phys. Polon.*, **10** (*No.* 3–4) 107–40 (1951).

For Pt I, see Abstr. 7968 (1950). A detailed theory involving three types of intermolecular coupling in liquids, namely pseudocrystalline interaction, association in antiparallel pairs, and further association of such pairs, explains the values of the dielectric polarization, the Kerr effect, electric saturation and the Cotton–Mouton effect of nitrobenzene in benzene over the whole concentration range. D. H. WHIFFEN

537.226.2

7836. Domain boundary motion in ferroelectric crystals and the dielectric constant at high frequency. C. Kittel. Letter in *Phys. Rev.*, **83**, 458 (*July* 15, 1951).

The surface energy of the boundary is increased when it is set in motion because of the inertia of the ions which change position due to changes in their effective dipole moments. For $BaTiO_3$, theory gives 2×10^9 c/s for the frequency at which the dielectric constant can be expected to relax. Agreement with experiment is good; a more exact theory would include frictional effects and a spread in domain widths. C. A. HOGARTH

537.226.2

7837. The dielectric constant of barium oxide. R. S. Bever and R. L. Sproull. *Phys. Rev.*, **83**, 801–5 (*Aug.* 15, 1951).

The availability of crystals of BaO made possible an investigation of the low frequency dielectric constant κ of BaO. This has been measured over the frequency range 60 to 6×10^7 c/s and the temperature range $-25°$ to 60°C. Over these ranges κ is about 34, which is quite different from the value of 14 frequently quoted. There is some evidence for a rise in κ at the lowest frequencies. Data on dielectric loss is presented. A.

537.226.2

7838. An electrostatically induced permanent memory. C. F. Pulvari. *J. Appl. Phys.*, **22**, 1039–44 (*Aug.*, 1951).

The possibility of using a ferroelectric substance (barium titanate) as a medium for storing information is described. Preliminary experiments were performed to determine the necessary conditions for inscribing and erasing electrostatic preorientation in barium titanate ceramics at a temperature somewhat below the Curie point. The results suggest the possibility of a memory device that can be operated in the range of audiofrequencies or higher. A.

537.226.2 : 538.221 : 621.3.011.5 : 621.318.2/.3

7839. On the dielectric and magnetic properties of several ferrites at high frequencies. F. Wagenknecht. *Frequenz*, **5**, 145–55 (*June*, 1951) *In German.*

The first part of an exhaustive treatment of the properties of Mg-, Mn-, Fe-, Ni-, Cu-, Pb- and Cu-Pb-ferrites prepared by various methods and measured for dielectric and magnetic properties in the region 170–3 285 Mc/s. The FeO–Fe_2O_3 system is given special attention. Numerous tables are presented showing the influence on the properties of the Cu–Pb ferrites of constitution, heating time, sintering temperature, speed of cooling, milling time, particle size and measurement frequency. S. C. DUNN (R.

537.226.2 : 543.712/.812 : 621.317.335.3 : 621.317.3

7840. Moisture determination by dielectric measurement. K. Kamiyoshi and T. Miyamoto. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 549–60 (*June*, 1950).

An electric humidity tester was constructed fo-

moisture determinations on materials such as cement, flour, etc., by measuring their dielectric constants. The tester is portable, and the measurement is prompt and needs no special technique. Relations between the humidity content and the apparent dielectric constants of these materials were investigated, and discussions of some possible sources of error in measurement are given. The anomalous high dielectric constant when the solid adsorbs humidity was also remarked. A.

537.226.2 : 548.736.4

7841. The Lorentz correction in hexagonal barium titanate. J. R. TESSMAN. Letter in *Phys. Rev.*, **83**, 677 (*Aug.* 1, 1951).

When the calculation is made for a simple hexagonal lattice, the required ionic polarizability of Ti ($1{\cdot}6\times10^{-24}$ cm^{-3}) is appreciably greater than the value required for the cubic modification and just reached at the Curie point. Thus this form of $BaTiO_3$ is expected to be non-ferroelectric, as found experimentally. C. A. HOGARTH

537.226.2 : 621.315.612

7842. Electrical ceramics and characteristics of ionic crystals. N. P. BOGORODITSKIĬ AND I. D. FRIDBERG. *Elektrichestvo*, *No.* 5, 52–6 (*May*, 1951) *In Russian.*

Electrical ceramics are here classified according to the electrical characteristics of the crystal phase. Their electric properties must be considered in their relation to those of the polycrystalline dielectrics, the similarly polycrystalline semiconductors of the electron type, and also of the ferroelectrics. The losses of these materials may be divided into (*a*) structural losses due to the loose packing of the ions in the crystal lattice when energy levels of the ion exist which prohibit its fixation (these are very similar to the structural dielectric losses in amorphous substances); (*b*) losses due to the electronic semiconducting nature of the crystal; (*c*) losses due to the normal dielectric conductivity of the material. The three main groups are: polycrystalline dielectrics represented by the minerals periclase, spinel, forsterite, clinoenstatite, mullite and cordierite; polycrystalline electronic semi-conductors such as corundum and rutile; ferroelectrics of the perovskite type. The characteristics of high-grade ceramic materials and parts obtained by new crystallization processes are given and h.v. and h.f. insulators and capacitors of these materials are shown. B. F. KRAUS (R)

537.226.8 : 541.183.5

The dielectric behaviour of vapours adsorbed on activated silica gel. *See Abstr.* 8312

537.228.1

7843. A new and quick method for detection of piezo-electricity and measurement of the piezo-electric constants. K. G. SRIVASTAVA. *Indian J. Phys.*, **25**, 33–4 (*Jan.*, 1951).

A method using a differential transformer has been developed for detection of piezo-electricity. To one of the primaries of the differential transformer the crystal is connected and to the other is connected a variable condenser and resistances in parallel. Balance is obtained at first and frequency of source is then varied. As soon as a crystal-frequency is approached a large current results in the secondary which detects the piezo-electric behaviour of the crystal. The method has been used to measure the piezo-electric constant of quartz. A.

537.228.1

7844. Piezoelectric behaviour of partially plated square plates vibrating in contour modes. R. BECHMANN AND P. L. PARSONS. *Proc. Phys. Soc., Lond. B*, **64**, 706–12 (*Aug.*, 1951).

In extension of a previous paper [Abstr. 5174 (1951)], the piezoelectric behaviour of partially plated square plates vibrating in contour modes is used to check the theoretical solution for the motion. For the longitudinal mode 2 recently described by Ekstein a particularly sensitive test of the theory is possible. A critical electrode arrangement should cause the piezoelectric excitation to vanish. This is confirmed by experiment. A.

537.228.4

7845. On Kerr cell construction. W. R. SMYTHE. Letter in *J. Appl. Phys.*, **22**, 1087 (*Aug.*, 1951).

Large parallel electrodes outside the dielectric, rather than small ones immersed in the dielectric, are suggested for maintaining a uniform electric field perpendicular to the optical axis.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3

7846. Expected number of crossings of axis by linearly increasing function plus noise. F. W. LEHAN. *J. Appl. Phys.*, **22**, 1067–9 (*Aug.*, 1951).

The expected number of times the function $e(t) = at + e_N(t)$ crosses the t axis in a positive direction prior to any given time is calculated, where $e_N(t)$ is a random noise function of arbitrary power spectrum. The solution is given as the product of two functions. Curves are presented for the two functions. A.

537.311.1

7847. Masses of carriers in conductors. D. L. WEBSTER AND C. M. NEWTON. *Phys. Rev.*, **82**, 808–9 (*June* 15, 1951).

Barnett and Brown present, in a recent paper [Brown and Barnett, *ibid.*, **81**, 657 (1951)], experimental evidence that supports the theoretical findings of Darwin in an earlier paper [Darwin, *Proc. Roy. Soc. A*, **154**, 61 (1936)], namely, that all metals should have the same effective m/e in acceleration, despite the differences in their Hall coefficients. The present paper derives the same conclusion from more elementary premises. A.

537.311.1

7848. Inertia of the carrier of electricity in cadmium. G. G. SCOTT. Letter in *Phys. Rev.*, **83**, 656 (*Aug.* 1, 1951).

Experiment shows conclusively that the carrier of electricity in Cd (which has a positive Hall coefficient)

is negative and that the mass-charge ratio is approximately the same as that of the electron.

R. B. DINGLE

537.311.3 : 539.21

7849. On the resistance of intermetallic compounds. I. Dustmann and G. Masing. *Nachr. Wiss. Göttingen, Math.-Phys. Kl. IIa, No.* 7, 10 *pp.* (1950) *In German.*

The problem of whether an intermetallic compound shall exhibit a low resistance like that of a pure metal or a high resistance, and whether such substances should be regarded as mixed crystals or true compounds, is discussed. Tamman's concept of "coherent atom chains" in such crystals is verified by experiments in which MgAg is used as an electrode in HCl. The potential of MgAg is practically the same as that of pure Ag, and corresponds to the concentration of Ag ions in the electrolyte in accordance with the Nernst formula. C. A. HOGARTH

537.311.31

7850. Metallic conduction—The "internal size-effect." D. K. C. MacDonald. *Phil. Mag.*, **42,** 756–61 (*July*, 1951).

The conception as an "internal size-effect" of internal boundaries in a metal is proposed and discussed in relation to a number of problems. The behaviour of the electrical resistance under a magnetic field is of particular interest and it is suggested that this may be relevant to the anomalous effects observed in Au (and other metals) at low temperatures and to the peculiar magneto-resistive characteristics of ferromagnetics. A.

537.311.31 : 537.323 : 538.221

7851. On the properties of chromium sulphides and iron sulphides. I. H. Watanabe and N. Tsuya. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2,** 503–6 (*June*, 1950).

Cr and Fe sulphides were prepared by sintering and their magnetic behaviour, electrical conductivity and thermoelectric power *v.* temperature were studied. The experimental results were checked by natural pyrrhotite; these substances are more like metals than semiconductors. Their band picture as proposed by Hirone and Miyahara should be modified by assuming that the conduction band overlaps the bands responsible for ferromagnetism. A.

537.311.33

7852. Investigation of the electric characteristics of thin oxide films by the method of the gas-discharge plasma. S. S. Gutin. *J. Tech. Phys., USSR*, **20,** 1210–12 (*Oct.*, 1950) *In Russian.*

The thickness of the layer was determined from the capacitance measured in a plasma, and was found to be $0{\cdot}5\ \mu$. With this value the resistivity was calculated to be $4{\cdot}5\text{–}7\times10^{12}$ ohm cm. This is about one order of magnitude lower than the value measured with metal electrodes. The relation between voltage and current through the film follows Ohm's Law up to a value of the field strength of the order 3·5 MV/cm; later on, Poole's effect becomes conspicuous. The method is particularly suitable for the films of aluminium oxide used in electrolytic capacitors.

B. F. KRAUS

537.311.33

7853. Theory of the contact of two semiconductors of different type of conductivity. A. I. Gubanov. *J. Tech. Phys., USSR*, **20,** 1287–301 (*Nov.*, 1950) *In Russian.*

Systematic experimental investigations of the contact of pairs of semiconductors with different conduction mechanisms were first carried out by Ioffe [Abstr. 2510 (1949)] who discovered two basic phenomena, viz. that the contact had a rectifying effect and that the resistance of the pair of semiconductors in the contact under a small applied voltage even in the direction of current passage was considerably higher than the sum of the resistances of the semiconductors measured separately between metal electrodes. For a vanishing potential difference the resistance in both directions tended towards the same limiting value. There are several theories available for attempting an explanation of these phenomena, of which those of Davydov, Blokhintsev, Pekar, Schottky and Spenke (all of 1938–9) are suitable up to a degree, but none capable of accounting for the whole complex of observations. The author's theory is founded on the assumption of the formation of a barrier layer between the two different semiconductors, but of an essentially different character from the barrier layers postulated by the earlier theories. The consideration of the influence of the contact potential, recombination processes between electrons and holes allowing for the effective recombination cross-section, and the nearly balancing diffusion flows and conductivity currents yield a model the mathematical evaluation of which leads to just those values of the current *v.* potential difference in either direction as were observed in the experiments. Applied to technical solid rectifiers, the theory supports the hypothesis, advanced already by the first investigators, that in this type of rectifier the rectifying effect occurs at the boundary of the semiconductors, and not at the boundary metal-semiconductor. An "apagogic" confirmation of this is the fact that the rectifying effect of solid rectifiers is much greater than predicted by the theory of the contact metal-semiconductor. B. F. KRAUS

537.311.3

7854. Studies on selenium and its alloys. (Report I. Some experiments on the rectifying characteristics [the] selenium rectifier.) T. Sato and H. Kanek. *Techn. Rep. Tôhoku Univ.*, **15** (*No.* 1) 1–10 (1950).

For Pt I, see Abstr. 6208 (1951). Experiments to determine the nature of the blocking layer are described: (1) The electrical resistance R of Se containing halogens, S, and Te, and of Se–Sn, Se–Bi and Se–Cd alloys was measured as a function of concentration. The halogen constant decreases R up to a certain point (ionization produces extra positive holes) but beyond this point R increases (due to the disturbance of the periodic field in the Se lattice). The alloys with Sn, Cd and Bi (contained in Wood's metal and sometimes used as a counter-electrode) are found to exhibit complex behaviour, the sudden changes in R with composition being considered due to the formation of compounds of lower resistivity, e.g. Bi_2Se_3, SnSe, $SnSe_2$. (2) The authors believe the blocking layer to consist of a thin layer of amorpho

Se. SeO_2 formed on the Se surface during the heat treatment absorbs moisture and produces selenious acid on which the counter electrode is sprayed. When the electro-forming process takes place there is electrolysis and a thin insulating layer of Se is deposited on the cathodic side. This layer may be detected macroscopically on a rectifying plate with an artificially formed oxide layer. These results, together with those of Part I concerning heat treatments, enable a complete qualitative explanation of the effects of general heating and of sudden impulse heating of Se rectifiers on the rectifying characteristics to be given. (3) Artificial barrier layers were deposited using Al_2O_3, S, organic substances, celluloid, varnish, enamel. The rectification ratio increases to a maximum for a certain thickness of blocking layer. When the thickness is great enough the direction of rectification is normal (Mott–Schottky theory), but for extremely thin layers (up to about 4×10^{-5} cm) the direction is reversed, as given by Wilson's tunnel-effect theory. C. A. HOGARTH

537.311.33

7855. Semi-conducting materials. *London, Butterworth Scientific Publications* (1951) 281 *pp.*

For abstracts see Abstr. 7856–71, 7882–9, 7891 (1951).

537.311.33

7856. Semi-conductors. N. F. MOTT. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 1–7.

This introductory paper deals with a number of problems concerning the theory of solids and, in particular, the theory of semi-conductors. These problems are discussed under three headings: (*a*) the nature of the impurity centres and the transition between metallic and temperature-activated conduction; (*b*) the optical properties of crystals; and (*c*) the existence of surface levels and the properties of inter-crystalline boundaries. Further theoretical and experimental work is needed in order to clarify these issues. A.

537.311.33

7857. On the energy states of impurities in silicon. G. W. CASTELLAN AND F. SEITZ. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 8–25.

Pearson and Bardeen have found that the ionization energy of carriers in pure Si to which P or B are added decreases with increasing concentration and becomes zero for concentrations in the vicinity of $5\cdot10^{18}$ per cm^3. This result is obtained from a range of temperature in which the fraction of donator or acceptor levels that are ionized lies between 1 and about 0·1, the most accurate values of the ionization energy being derived from the latter end of the range. Pearson and Bardeen have suggested that the decrease in ionization energy arises from the attractive Coulomb interaction between the free carriers and the ionized impurity atoms. It is pointed out that if this is the important interaction, its contribution should depend primarily upon the density of carriers and not upon the density of impurity atoms, and should become very small when the density of carriers is small. In fact the agreement found by Pearson and Bardeen on the basis of their assumption diminishes when as few as a tenth of the centres are ionized. Moreover, the experimental evidence suggests that the ionization energy actually depends upon the total density of impurity atoms and not upon the density of free carriers. A search for another source of reduction of ionization energy has been made without success using the conventional approximations of quantum theory. It is found that such factors as the overlapping of carriers on different impurity atoms and the polarization of the neutral impurity atoms by the carriers and ions make a negligible contribution to the energy of the system if treated in the usual way. Moreover statistical fluctuations in the density of impurity atoms do not seem to be of significance. The origin of the transition from "insulating" to "metallic" characteristics appears to be obscure. Possible explanations are offered. A.

537.311.33

7858. New phenomena of electronic conduction in semi-conductors. W. SHOCKLEY. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 26–36.

The semiconductors Si and Ge may be discussed as insulators whose electronic structure is disturbed. Excess electrons, which act as negatively charged current carriers, may be present as "holes" or places where electrons are missing from the valence-bond structure. Holes act as positively charged current carriers. In ordinary electronic conduction the flow of current carriers is substantially incompressible so that the density of carriers remains constant. When a new transistor phenomenon known as "carrier-injection" occurs, however, the total density of holes and electrons may be greatly increased and this modulation of the electronic structure may be used both for scientific investigation and for practical amplification. In particular, carriers may be injected at a predetermined time and place into a known uniform electric field and their transit time to another place accurately timed by detecting their arrival at a "collector" point. Drift velocities and mobilities may be measured precisely in this way with a directness unattainable by pre-transistor methods involving conductivity and Hall effect. These new experiments and their related theories may furnish a foundation for a new engineering science of transistor electronics. A.

537.311.33

7859. Semi-conductor surface phenomena. W. H. BRATTAIN. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 37–46.

The developments in the understanding and interpretation of phenomena occurring at the surface of a semiconductor are reviewed. The development starts with the Mott–Schottky theory of the space charge layer. Bardeen's concept of a space-charge layer due to "surface states" explained the independence of rectification on contact potential and Meyerhoff's small values for the contact potential between *n* and *p*-type Si. Shockley and Brattain observed that this contact potential difference increased with impurity concentration. Illumination of a Si surface produces

hole and electron pairs in the space-charge layer. The potential of the surface changes until the photo-current is balanced by a conduction current. The relation between photo-current and potential change is of the same form as a forward characteristic for a rectifying contact. In an experiment similar to Becquerel's, using water as an electrolyte, the surface may be biased in the reverse direction. When so biased, the response to modulated light gives the differential resistance of the space-charge layer. This resistance rapidly increases with reverse bias and the time constant of the layer (RC) increases, both agreeing qualitatively with theory. This experimental method of measuring changes in surface potential caused by illumination permits the determination of the properties of the space-charge layer at the free surface of a semiconductor. A.

537.311.33

7860. Nucleon-bombarded semi-conductors. K. LARK-HOROVITZ. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 47–69.

Three types of effects due to nucleon bombardment are discussed: permanent effects due to transmutations which are particularly important in irradiation by slow neutrons; transient effects produced by the passage of heavy particles and electrons; and reversible effects produced by fast nucleons. These are due to vacancies and interstitials produced by collision, and the original condition of the lattice can be restored by heat treatment. Using fast electrons, it is possible to find the threshold energy necessary to produce a vacancy or interstitial in the Ge lattice (about 25 to 30 eV), in agreement with estimates made previously. The use of well-defined beams allows the production of *p–n* barriers in Ge and hence leads to the possibility of studying the properties of such barriers as a function of thickness and concentration of carriers. In other semiconductors, such as Si, Te and PbS, irradiation leads primarily to a very large decrease in conductivity.

Appendix I. Effect of bombardment upon a classical semi-conductor in thermal equilibrium. V. A. JOHNSON AND K. LARK-HOROVITZ (*pp.* 70–3).

Appendix II. Fermi levels in bombarded semi-conductors. H. M. JAMES AND G. W. LEHMAN. (*pp.* 74–7).

537.311.33

7861. Recent experiments on lead sulphide contacts. H. K. HENISCH AND J. W. GRANVILLE. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 87–94.

The voltage-current characteristics of PbS contacts are described and the effect of temperature, whisker material, forming phenomena, etc., on them is discussed. A close similarity between Ge and PbS is observed, including negative resistance characteristics, sometimes in both directions of current flow. The specimens used for this investigation were known to have pronounced photovoltaic properties and had been found to show crystal triode action. A.

537.311.33

7862. Electrical characteristics and anomalies of germanium. P. R. AIGRAIN, C. R. DUGAS AND H. W. ETZEL. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 95–105.

I. **Rectification and transistor effect in germanium.** A new theory is presented which pre-supposes the existence of a surface layer containing acceptor impurities on *n*-type bulk Ge. With this model, the d.c. characteristics of Ge rectifiers, the high back-voltage curve, and the sensitivity of Ge diode current-voltage curves to temperature are satisfactorily explained. Furthermore, the theory is capable of explaining current gain in transistors and permits the calculation of transistor characteristics with a very high precision.

II. **Anomalies of germanium.** Bethe's theory according to which an impurity ion in a crystal lattice will attract an electron and bind it in a Coulomb field is used as a basis for explaining some of the anomalies observed in semiconductors. The anomaly in the specific heat of Ge is partially accounted for, and the variation of susceptibility with temperature is also attributed to the interaction between electrons and impurity ions. The theory predicts a change of Hall constant and conductivity with magnetic field strength. A.

537.311.33

7863. Electron traps and electron conduction in irradiated alkali halide crystals. R. W. POHL. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 106–13.

The known properties of *F*-centres as a source of photo-electrons and of *F'*-centres as electron traps are summarized. Experiments on alkali halide crystals irradiated by X-rays are described. They provide evidence for the existence of a new type of electron trap, due to traces of alkaline earth contamination. Experiments under alpha-particle irradiation show that alkali halide crystals are suitable for use as crystal counters. A.

537.311.33

7864. The motion of electrons and holes in silver chloride. L. P. SMITH. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 114–21.

Investigations pertaining to the movement of electrons and holes in AgCl single crystals are reported. It has been definitely established that holes as well as electrons move in these crystals. Conductivity was induced by electron bombardment. Experiments were carried out at low and high current density and at several temperatures. Values are given for the mean time an electron remains in the conduction band and the mean time a hole remains in the filled band, and for the mobility of holes and electrons. Observations indicate that space charge effects are important and that at some temperatures there is trapping and subsequent release of electrons. For temperatures of approximately — 70°C it is possible to establish that electrons traverse the entire crystal. Holes are never found to get all the way through the crystal. Differences between the results reported here and those of some other investigators are briefly discussed. An estimate is made of the concentration of traps for electrons and holes. A.

537.311.33

7865. Oxidic semi-conductors. E. J. W. VERWEY. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 151–61.

The poor conductivity of most oxides of the transition elements can be understood if one considers that approximate wave-functions in these lattices should be obtained according to a Heitler–London type treatment starting with the atomic wave function of the metal ions. This implies that an appreciable conductivity can be realized only if the oxide contains ions of the same element of different charge in the same crystallographic position, as in Fe_3O_4 or in "non-stoichiometric" compounds. The latter condition can be satisfied in an easily controllable way, suitable for the preparation of sintered oxidic semiconductors, by making solid solutions of two compounds of widely different conductivity (e.g. Fe_3O_4 and a non-conducting spinel) or by applying the principle of "controlled valency change." In the latter case a foreign ion (e.g. Li^+) is incorporated into the lattice of the oxide (e.g. NiO), so that the partial O pressure of the oxide is so much changed that in the high temperature treatment an equivalent amount of ions of deviating valency (Ni^{3+}) is formed by taking up O from the gas atmosphere. The influence of impurities upon the conductivity of this type of semiconductor is discussed and compared with the phenomena in other cases (e.g. Ge). Ceramic semiconductors generally show a very high value of the dielectric constant at low frequencies. Values up to 10^6 have been found. This phenomenon is effected by the presence of very thin layers of an increased electrical resistance within the material, mostly at grain boundaries. These layers may be caused by minute "air gaps" between the crystals due to an imperfect fitting together, but in addition minor chemical changes at the grain boundaries may play a part. The layers may increase the resistance considerably. As a consequence of these phenomena, the true conductivity of this type of semiconductor can be obtained only by measuring the resistance at a sufficiently high frequency. A.

537.311.33

7866. Some properties of (La, Sr)MnO_3. J. VOLGER. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 162–71.

As an example of the controlled-valency principle, semiconducting "manganites" in the form of polycrystalline products had been prepared by Jonker and van Santen [see Abstr. 309 (1951)]. They also found that there exists a close relation between the resistivity ρ and ferromagnetism, the slope of the $\log \rho$ *v.* $1/T$ curve showing an anomaly at the Curie temperature. In a certain composition range, a positive temperature coefficient of ρ, of the same order as for metals, was found even below this temperature. More details on the conductive properties of the compounds are given, i.e. results on the frequency dependence of ρ, its dependence on voltage and applied magnetic field, and results concerning the Hall-effect and the thermo-electric force. The bulk conductivity and second-order effects will be discussed. A.

537.311.33

7867. Electrical and optical properties of zinc oxide. P. H. MILLER, JR. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 172–9.

ZnO is often regarded in the literature as a typical semiconductor. The purpose of the present paper is to point out: firstly, that the usual interpretation of electrical conductivity and Hall-effect data on sintered specimens gives incorrect values for the mobility because of grain boundary effects; secondly, that analysis of the Hall data is inconsistent with a single impurity level semiconductor; and thirdly, that the value of the forbidden bandwidth as obtained by studies of electrical conductivity as a function of temperature, optical absorption, photo-conductivity as a function of wavelength, fluorescence spectra and the structure of the *K* absorption edge, varies from 1·5 to 6 eV. No simple interpretation of these diverse observations appears possible at this time. A.

537.311.33

7868. The properties of semi-conducting oxides. T. J. GRAY. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 180–7.

The semiconductivity of certain oxide systems is discussed with particular reference to the variations occurring during the adsorption and desorption of O. The kinetics of these processes have been studied and lead to a model for the surface zone semiconductivity of an oxide for which the activation energies of the individual stages may be deduced. The effect of defect interaction is demonstrated and discussed. A.

537.311.33

7869. Electronic properties of gray tin. G. BUSCH, J. WIELAND AND H. ZOLLER. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 188–97.

Grey Sn of high purity has been prepared by prolonged cooling of spectroscopically pure metallic Sn. Numerous alloys have been made by adding small amounts of different elements. So far grey Sn has been obtained only in the form of a powder. Special methods for studying the electrical conductivity are therefore necessary. Since grey Sn is converted back to white Sn under elevated pressure, measurements on compressed samples of grey Sn powder are unreliable. The conductivity has been determined by measuring the Q-factor of a coil containing a core of grey Sn powder at frequencies up to 30 Mc/s. With decreasing temperature the conductivity decreases according to an exponential law. Intrinsic conductivity with an activation-energy of about 0·1 eV is found down to − 100°C. At 0°C the conductivity reaches a value of $5 \cdot 10^3\ \Omega^{-1}\text{cm}^{-1}$. At low temperatures it strongly increases with increasing amount of added impurities. Hall effect and the change of resistivity in a magnetic field have been measured by conventional methods with special precautions. The Hall-coefficients are found to increase rapidly with decreasing temperature. Remarkably high changes of the resistivity in magnetic fields have been observed. Large thermoelectric e.m.f.'s are generated at a junction of grey and white Sn. The experiments show

that grey Sn is a semiconductor of high electrical conductivity with properties very similar to Si and Ge. A.

537.311.33

7870. Measurement of the temperature dependence of conductivity and Hall coefficient in lead sulphide and lead telluride. R. P. CHASMAR AND E. H. PUTLEY. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 208–17.

Measurements are described of the variation of conductance with temperature of photo-conductive layers of PbS and PbTe over the range 90°K to 300°K both in the dark and with illumination. It is shown that the results can generally be fitted to the formula conductivity $\sigma = \sigma_0' \exp(-T_A/T + T/T_B)$. The significance of this expression is discussed. The Hall coefficient and conductivity of polycrystalline ingots of PbTe have been measured from 77°K to 1 000°K. At low temperatures the specimens behaved as *n*-type or *p*-type impurity semiconductors, but above 500°K PbTe behaves as an intrinsic semiconductor. The distance between the full and empty bands was found to be 0·62 eV. The electron mobility in these specimens was about 1 000 times the value found in evaporated layers at room temperature. The ratio of the mobility of an intrinsic electron to that of a hole was found to be 4. A.

537.311.33

7871. Some experimental studies of the resistance and electro-motive force of selenium blocking-layer cells. A. E. SANDSTRÖM. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 218–33.

The blocking-layer resistance of an un-illuminated Se photo-cell is considerably reduced by a strong previous illumination. As soon as the illumination is discontinued, the resistance increases with time, following a roughly exponential curve. Deviations from the simple function indicate that two or more effects overlap. One of these arises from the very low blocking layer resistance during illumination. An equivalent circuit can be developed with the aid of which the resistance can be computed for photo-voltages other than that corresponding to an infinite external resistance. Curves giving the blocking layer resistance as a function of the photo-voltage show the same characteristic features as the corresponding resistance/voltage curves of un-illuminated elements. Experiments show that the changes observed on the un-illuminated cell are due to causes other than the large reduction of the blocking-layer resistance during illumination. The variations of the resistance are subject to hysteresis effects. Some conclusions can also be drawn as to the value of the photo-electromotive force. The ratio of this electromotive force to the photo-voltage for infinite external resistance is very dependent on the intensity of illumination. A.

537.311.33

7872. On the theory of galvanomagnetic effects for mixed conduction. H. WELKER. *Z. Naturforsch.*, **6a**, 184–91 (*April*, 1951) *In German.*

The values of Hall coefficient in semiconductors are worked out for mixed conduction when holes and electrons are present simultaneously, for the cases of direct and alternating electric fields, and for both surface and volume recombination. A dependence of Hall constant on both magnetic field and frequency is predicted. The formulae are discussed in the light of experiments on Ge, notably those of Shockley, Pearson and Haynes [*Bell Syst. Tech. J.*, **28**, 344 (1949)] and the existence of a superficial magnetic barrier layer is postulated. C. A. HOGARTH

537.311.33

7873. On the electrical properties of thin films of germanium. J. M. DUNOYER. *J. Phys. Radium*, **12**, 602–6 (*May*, 1951) *In French.*

Electron diffraction and microscopic evidence has already shown that Ge films can be amorphous or crystalline. Measurements of electrical resistance R of vacuum-evaporated Ge films approximately 1 micron thick were made, and for films deposited on cold substrates there was a rapid decrease in R when the temperature reached about 350°C, by a factor of about 10^6, e.g. from 10^5 to 10^{-1}. The effect of heating the substrate when the ambient temperature was also varied was to cause the rapid decrease in R to occur at a rather higher temperature ($\simeq$ 400°C). The high-R films are assumed to be amorphous; the films are assumed to be crystalline if deposited on a substrate heated to 300°C. If an amorphous film is subsequently crystallized, the transition temperature is given as 375°C. Whisker-contact experiments have demonstrated rectification effects, the amorphous films withstanding the higher reverse voltages, whereas the crystalline films pass the higher forward currents. Despite the apparent uniformity of the films there were wide variations in contact properties from one point to another. C. A. HOGARTH

537.311.33

7874. Rectifier effect of thin semiconductive layers that are illuminated asymmetrically. G. WLÉRICK. *C.R. Acad. Sci., Paris*, **232**, 2199–201 (*June* 11, 1951) *In French.*

Red light increases the conductivity of the semiconductor (CdS)-metal barrier less than it increases the conductivity of the semiconductor. CdS, which is very little ionized in darkness, is readily photo-ionized and shows this new type of rectifier effect. One contact is kept dark while the other is illuminated. The light diminishes the thickness of the semiconductor-metal barrier, but increases the contact potential. An internal barrier appears along the boundary of the light beam. The rectification is explained by the presence of two contacts and an internal barrier. W. SUMMER

537.311.33

7875. The combination of resistivities in semiconductors. V. A. JOHNSON AND K. LARK-HOROVITZ. Letter in *Phys. Rev.*, **82**, 977–8 (*June* 15, 1951).

Corrections and re-calculations of previous work [Abstr. 8740 (1950)] based on discussions due to Schottky, Schockley and to Jones [Abstr. 3527 (1951)]. Mobility values higher than those of Jones are calculated. C. A. HOGARTH

537.311.33

7876. Internal barriers in semi-conductors. H. K. HENISCH. *Phil. Mag.*, **42**, 734–8 (*July*, 1951).

The temperature-dependence of conductivity is

calculated for a semiconducting specimen containing internal barriers of various heights. This leads to a new interpretation of activation energies as deduced from conduction measurements. A.

537.311.33

7877. Erratum: Resistivity and Hall constant of semiconductors. C. N. KLAHR. Letter in *Phys. Rev.*, **83**, 460 (*July* 15, 1951). See Abstr. 5406 (1951).

537.311.33

7878. Conductivity, Hall effect and thermo-electric power of selenium single crystals. K. W. PLESSNER. *Proc. Phys. Soc., Lond. B*, **64**, 671–81 (*Aug.*, 1951).

Single crystals of Se have been grown from the vapour phase and their conductivity and thermo-electric power were measured over a range of temperatures. The Hall effect was determined for one crystal. The conductivity obeys a relatively simple exponential law $\sigma = \sigma_0 \exp(-eE/kT)$, with $eE = 0{\cdot}13$ eV and the room temperature conductivity between 10^{-5} and $0{\cdot}5\times10^{-6}$ ohm^{-1} cm^{-1}. Both thermo-electric power and Hall effect rise slightly with increasing temperature, indicating a fall in the current carrier concentration. Values calculated from thermo-power and Hall effect agree reasonably well, and give about 10^{14} positive holes per cm^3. Because of an experimentally established correlation between thermo-power and conductivity, differences in conductivity between various crystals are ascribed to different hole concentrations. Deviations from Ohm's law, the rapid increase in mobility with temperature and its low absolute value (about $0{\cdot}14$ cm^2/V sec at room temperature) all point to the existence of potential barriers within the crystals. It is shown that a range of barriers of different heights could explain the observed behaviour. The conductivity is anisotropic (ratio about 10 : 1), whereas the thermo-power is not. A.

537.311.33

7879. Conductivity and Hall effect of micro-crystalline selenium containing iodine impurities. K. W. PLESSNER. *Proc. Phys. Soc., Lond. B*, **64**, 681–90 (*Aug.*, 1951).

The conductivity and Hall effect of micro-crystalline Se have been measured as a function of I content under two different conditions of crystallization, over a range of temperatures. The conductivity increases with I concentration, a maximum being reached at a concentration of about $0{\cdot}03$ atomic %. The Hall effect shows this increase to be due to an increasing mobility, the carrier concentration remaining nearly constant. The effect of carrying out the first crystallization of the amorphous Se at 175°C instead of 110°C is to reduce the conductivity by a factor of 10. This is due to reductions in both mobility and current carrier concentration. With increasing temperature the mobility rises and the carrier concentration falls, the product of the two resulting in a rising conductivity with samples crystallized at 175° and a slightly falling conductivity with samples crystallized at 110°C. The results are discussed in terms of the grain structure of the material. Microscopic examination has shown that the grain size is different for different crystallization temperatures and it is suggested that larger crystals contain a smaller density of acceptor centres. The fall in carrier concentration with increasing temperature is thought to be due to the relief of stress set up due to anisotropic contraction when the material is cooled from the annealing temperature. The low absolute value of the mobility and its rise with temperature are ascribed to intergranular high resistance barriers. A.

537.311.33

7880. Some conduction properties of the oxides of cadmium and nickel. C. A. HOGARTH. *Proc. Phys. Soc., Lond. B*, **64**, 691–700 (*Aug.*, 1951).

The electrical conductivity and thermo-electric power of specimens of CdO and NiO are measured as functions of temperature and of O pressure, and the results are found to agree in general form with theories previously proposed by C. Wagner and by the present author. The results are used to verify Wagner's concept of a differential thermo-electric circuit, and a band model for CdO is proposed. A.

537.311.33

7881. The conductivity-temperature characteristics of lead sulphide: the influence of oxygen and of the rate of heating. W. EHRENBERG AND J. HIRSCH. *Proc. Phys. Soc., Lond. B*, **64**, 700–6 (*Aug.*, 1951).

In general, the conductivity-temperature curves of impurity semiconductors should be affected by the rate of heating. An arrangement is described by which such curves can be recorded with rates of heating up to 5 000°C/sec. Extensive tests made on PbS films in an oxygen atmosphere lead to conclusions about the stages of oxidation. A.

537.311.33 : 535.39–15

7882. Infra-red optical properties of silicon and germanium. H. Y. FAN AND M. BECKER. "*Semiconducting materials.*" *London, Butterworths Scientific Publications* (1951) 132–47.

Si and Ge are found to have a high transparency for i.r. radiation beyond a sharp absorption edge. The absorption coefficient is determined by measurements of transmission through bulk samples. It increases towards long wavelengths and is larger for samples of lower resistivity. The absorption, though small, is higher than predicted by either the usual or a more elaborate theory of absorption by free carriers. On the other hand, measurements on neutron-irradiated Si show that free carriers do play an important role in the absorption. Measurements at low temperatures show that, in certain cases, localized energy states are important for the absorption. The position of the sharp absorption edge checks approximately with the known width of the energy gap and shifts with temperature. Theoretically calculated temperature-dependence of the energy gap, which agrees with estimates based on electrical measurements, is in good agreement with the observed shift in Si, but is too small to explain the shift in Ge. Reflectivity measurements by Lark–Horovitz and Meissner are also reported. Both materials have constant reflectivity over wide regions in the i.r., from which the index of refraction is calculated to be $3{\cdot}5$ and $4{\cdot}0$ for Si and Ge respectively. With high transparency and constant large index of refraction these materials may find useful application in i.r.

work, and the sharp rise of the absorption edge enables the materials to be used for the production of good filters. A.

537.311.33 : 537.221

7883. The work function of germanium. E. W. J. MITCHELL AND J. W. MITCHELL. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 148–50.

The contact potential difference between a Ge film deposited by vacuum evaporation on a polycrystalline W strip has been determined as $-0{\cdot}21 \pm 0{\cdot}03$ eV, using a retarding potential method. From this value the thermionic work function can be deduced if the concentration of impurity centres in the Ge is known. A.

537.311.33 : 537.312.5

7884. Semi-conduction and photo-conduction in barium oxide crystals. R. L. SPROULL AND W. W. TYLER. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 122–31.

A brief description is given of the method of growing BaO crystals. The electrical conductivity of these crystals has been measured in the temperature range 300°C to 1 000°C. Semiconductive behaviour similar to that of ZnO is reported. Optical absorption measurements on both films and crystals of BaO indicate a threshold energy of 3·9 eV for absorption. Photoconductivity begins at the same photon energy. Results of studies of photoconductivity as a function of wavelength, temperature and electric field strength are presented. A.

537.311.33 : 537.312.5

7885. The electrical and optical properties of certain sulphides, selenides and tellurides. R. A. SMITH. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 198–207.

The class of substances consisting of compounds formed between certain metals and S, Se and Te is characterized by having a small energy gap between the full and conduction bands, together with impurity levels lying very near these bands. This results in some interesting and unique characteristics such as the photoconductivity in the i.r. These substances are impurity semiconductors at temperatures below 400°K and intrinsic semiconductors at higher temperatures. Experiments on microcrystalline layers show interesting features but the effect of intercrystalline barriers masks the true behaviour of the bulk material. The Pb group PbS, PbSe, PbTe show marked photoconductivity extending to wavelengths of 4·4, 5·5 and $6{\cdot}0 \times 10^{-4}$ cm respectively at a temperature of 90°K. The long-wave limit moves to a longer wavelength as the sample is cooled. The Bi group Bi_2S_3, Bi_2Se_3, Bi_2Te_3 behaves similarly but the long-wave cut-offs occur at shorter wavelengths than for the Pb group. Several other substances of this type also show photoconductivity in the i.r. but at shorter wavelengths. The absorption spectra of solid PbS, PbSe, PbTe show strong absorption edges corresponding to energies of approximately 1·4, 1·05, 0·9 eV respectively. These are thought to correspond to transitions from the full to the conduction band. In addition there is fairly strong absorption in long-wave "tails." For PbTe the "tail" extends to about 12×10^{-4} cm and at the maximum the absorption is about 10^4 cm^{-1}. These may be due to transitions from the conduction band to a higher band. Hall constant measurements give a value of 0·62 eV for the energy gap between full and conduction bands for PbTe. Various theories of the photoconductive process for these substances are discussed. A.

537.311.33 : 537.32

7886. On the thermo-electric properties of selenium. H. K. HENISCH AND M. FRANÇOIS. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 234–45.

An apparatus for rapid thermo-electric measurements on cylindrical Se specimens is described. It is inferred from the temperature-dependence of the thermo-power that semiconducting Se contains free, non-activated positive holes. Experiments with specimens of different impurity content suggest that neither Hg nor I by themselves act as impurity centres in the accepted sense when added to the Se before melting, though Hg and I together seem in effect to function as a hole trap. Hg produces a rapid diminution of thermo-power when added to the Se by diffusion. The theory of thermo-electric effects is extended to semiconductors of very small activation energy. On the basis of the present thermo-electric measurements and results obtained by other workers, a tentative model for the conductive mechanism in Se is proposed. This model stresses the importance of granular structure and illustrates the relation between activation energies determined by conductive and thermo-electric measurements respectively. A.

537.311.33 : 539.11

Theory of the temperature effect of electronic energy bands in crystals. *See Abstr.* 8083

537.311.33 : 539.234

7887. Electrical conductivity of very thin metallic films evaporated in high vacuum. N. MOSTOVETCH AND B. VODAR. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 260–81.

Measurements have been made of the d.c. electrical resistance of layers a few atoms thick, evaporated on glass. The following metals were studied at temperatures down to 2°K: Pt, Rh, Ta, W, Mo, Ni, Fe, Cu, Al. The observed phenomena are: (1) action of absorbed gases, which may be reversible or irreversible, and decreases the resistance; (2) variation with temperature, which is exponential, the excitation energy changing with film thickness and structure; (3) effect of applied potential expressed by a linear relation between log $R(F)$ and $F^{\frac{1}{2}}$, F being the average field. This is a true field effect and is not due to Joule heat. The results show that the very thin metallic layers behave like semiconductors with very small excitation energy, which depends on the height of the potential wall between two atoms or particles. The action of the field is a modified form of the Schottky effect. The occurrence of the potential wall is due to either the wide spacing of the particles or the fact that metallic conduction bands are not possible in two-dimensional arrays. A.

537.311.33 : 548.5

7888. On the crystallisation of semi-metals and the formation of lattice defects. H. KREBS. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 246–53.

Changes in the electrical behaviour of hexagonal Se brought about through thermal treatment are accompanied by changes in the character of the lattice. The high-polymeric nature of black Se gives rise to a micellar structure with a special type of stable lattice disturbance. Admixtures which alter the conductivity also cause a change in the speed and the quality of crystallization by catalytic processes which can be interpreted. Crystallization of the amorphous phase of Te, P, As, Sb and C follows the same rules, that is, a disturbed micellar structure is formed to a smaller or greater extent. Similar catalytic processes can also be observed. Si and Ge are expected to behave in the same way. A thorough investigation of the thermal and catalytic condition of crystallization involving the preparation of certain disturbed lattices may lead to a method of influencing the electrical properties of semi-metals more effectively than has been possible hitherto. A.

537.311.33 : 621.314.63

7889. Crystal triode action in lead sulphide. P. C. BANBURY, H. A. GEBBIE AND C. A. HOGARTH. "*Semi-conducting materials.*" *London, Butterworths Scientific Publications* (1951) 78–86.

Certain specimens of deficit-conducting PbS have been found to exhibit crystal-triode action, and some properties of these units are described. Voltage gains as high as 150, and power gains of 15 have been obtained, while current gain has not been observed, despite the use of various forming treatments which have proved useful in the case of Ge transistors. The emitter contact is biased negatively and the collector positively, as for the *p*-type Ge transistor. The voltage gain starts to decrease with increasing frequency of incoming signal, between 100 kc/s and 1 Mc/s. The application of a transverse magnetic field changes the frequency response and it is deduced from the direction of the effect that negative charges are flowing from emitter to collector, i.e. that electrons are injected into the PbS from the negatively-biased emitter contact. A.

537.311.33 : 621.314.63

7890. Effect of auxiliary current on transistor operation. H. J. REICH, P. M. SCHULTHEISS, J. G. SKALNIK, T. FLYNN AND J. E. GIBSON. Letter in *J. Appl. Phys.*, **22,** 682–3 (*May*, 1951).

Characteristics, in particular the frequency response, of Ge triodes can be improved or varied using auxiliary d.c. electrodes critically positioned with respect to the collector electrode. Improvement is best if emitter/collector spacing is large and initial gain small. A. SCZANIECKI

537.311.33 : 621.315.59

7891 Engineering and chemical aspects of semiconductors. T. R. SCOTT AND S. E. MAYER. "*Semiconducting materials.*" *London, Butterworths Scientific Publications* (1951) 254–9.

A brief résumé is given under the headings: polycrystallinity, heterogeneity and chemical interfaces. The illustrations are in general drawn from the technology of Se rectifiers, but some reference is made to the barrier phenomena exhibited by Ge, Si, etc. Some aspects of TiO_2 technology are also included. A.

537.311.4

7892. Height of the potential barrier in contact rectifiers and its change with temperature. E. BILLIG AND M. S. RIDOUT. Letter in *Nature, Lond.*, **167,** 1028–9 (*June* 23, 1951).

The height of the barrier was determined from the temperature dependence of the contact resistance. The results were Ge = 0·60 V, Se = 0·53 V, Si = 0·38 V. The barrier height falls almost linearly with temperature for $T < 200°K$. A. H. W. BECK

537.311.5 : 621.3.015

7893. Conduction of current in a metallic pipe filled with a conducting liquid. H. PORITSKY AND H. WEIL. *J. Appl. Phys.*, **22,** 1002–5 (*Aug.*, 1951).

The electric potential across a metallic pipe is investigated when current enters and leaves through two diametrically opposite points and the pipe is either empty, filled with a conducting fluid, or lined with a thin film of the fluid. A.

537.312.5

7894. The characteristics of long period photo-effects in lead sulphide. R. P. CHASMAR AND A. F. GIBSON. *Proc. Phys. Soc., Lond. B,* **64,** 595–602 (*July*, 1951).

A photoconductive effect having a decay time of several hours has been observed in specially prepared layers of $PbSO_4$ when maintained at low temperatures. These effects are characteristic of layers that have been treated in a certain manner with S or with O. The general properties of the layers showing this photo-effect have been investigated. It is found that there are no first-order differences between the properties of the layers containing O and those containing S. It is suggested that the phenomena are associated with the excitation of electrons from the upper filled band of the $PbSO_4$ and the trapping of these electrons probably on the surface of crystallites. The depth of the traps is estimated to be of the order of 0·3 eV below the bottom of the conduction band. A.

537.312.5

7895. The sensitivity and response time of lead sulphide photoconductive cells. A. F. GIBSON. *Proc. Phys. Soc., Lond. B,* **64,** 603–15 (*July*, 1951).

Measurements of the response time and photosensitivity of $PbSO_4$ photoconductive cells have been made with a view to establishing a theoretical working model for photoconductors of this type. The measurements include the variation in response time and photosensitivity with temperature, background illumination, applied electric field and other parameters. The results support, at least qualitatively, a theory of photoconductivity which postulates the existence of space-charge barriers at intercrystalline contacts. The height of such barriers is reduced on illumination and conduction facilitated. A.

537.312.5

7896. Photoconductivity of composite photoemissive cathodes. S. PAKSWER AND W. O. REED. Letter in *J. Appl. Phys.*, **22,** 987–8 (*July*, 1951).

Describes experiments to determine whether the

photo-emission from a composite cathode is a surface effect or a volume effect or is due to emission from the metal atoms adsorbed. Experimental difficulties, which are fully discussed, precluded a clear-cut decision. A. H. W. BECK

537.312.5

7897. Observations of Zener current in germanium *p–n* junctions. K. B. McAfee, E. J. Ryder, W. Shockley and M. Sparks. Letter in *Phys. Rev.*, **83**, 650 (*Aug.* 1, 1951).

Zener current (due to carrier excitation directly from the valency to conduction band under a high electric field) is calculated as $I = 10V[11 - 10^7E]$ A cm^{-2} for Ge, where V is the critical voltage drop and E the electric field. The general behaviour of the V–I curve is in agreement with theory, and for various junctions with critical voltages from 1 to 10^3 V, the critical field E is always about 2×10^5 V/cm (measured under pulse conditions). C. A. HOGARTH

537.312.5

7898. Photoconductivity and photoelectric emission of barium oxide. H. B. DeVore and J. W. Dewdney. *Phys. Rev.*, **83**, 805–11 (*Aug.* 15, 1951).

Barium oxide, in the form of a sprayed coating on a Ni base, was investigated by means of studies of photoconductivity, photo-emission and absorption measurements and the variation of these with temperature. Changes occurring during activation of the oxide were observed. The results are discussed in terms of an energy level structure for BaO. A.

537.312.5 : 535.341

Photoconductivity in barium oxide. *See Abstr.* 7693

537.312.5 : 535.343.2

7899. Connection between the internal photo-effect and light absorption in silver halide salts. B. Barshchevskiĭ. *J. Exp. Theor. Phys., USSR*, **20**, 795–806 (*Sept.*, 1950) *In Russian.*

An investigation is made of the spectral distribution of the internal photo-effect relative to equal energy of absorption in AgBr and AgCl. It is shown that there are regions of selective internal photo-effect. An increase of the photo-effect in monocrystalline layers due to previous irradiation is considerably greater than the corresponding increase in absorption.

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537.312.5 : 537.311.33

Semi-conduction and photo-conduction in barium oxide crystals. *See Abstr.* 7884

537.312.5 : 539.21

7900. External photoelectrons from F' centres in RbI. E. Taft and L. Apker. Letter in *Phys. Rev.*, **83**, 479 (*July* 15, 1951).

Following earlier studies of external photoelectrons from F centres [Abstr. 4391 (1951)] it is shown that the electron distribution includes electrons from F' centres, the latter being formed by F band irradiation. G. F. J. GARLICK

537.312.5 : 621.383

7901. The time dependence of the sensitivity of photomultiplier tubes. M. Hillert. *Brit. J. Appl. Phys.*, **2**, 164–7 (*June*, 1951).

The particular phenomenon which takes place in the first minutes after a sudden alteration has been made in the illumination, was investigated in detail. An expression is given, capable of describing this change in the case of a sudden increase in the illumination to which the tube is submitted. Certain experimental results indicate that the dynodes are responsible for this effect. Finally, an electrical model of the behaviour of the dynodes is outlined, which functions according to the expression found for the time dependence of the sensitivity. A.

537.312.6

7902. On θ values in the resistance of metals. M. Blackman. *Proc. Phys. Soc., Lond. A*, **64**, 681–3 (*Aug.*, 1951).

The θ value to be expected on the Bloch theory of the temperature dependence of the resistance of metals is shown to be much larger than that observed experimentally. A.

537.312.62

7903. Experiments relating to the penetration depth in superconductors. M. C. Steele. *Overseas Res. Rep.* (*Dep. Sci. Industr. Res. Lond.*) 87/51 [*Off. Tech. Serv. Wash., PB* 101422].

Naval Research Laboratory, Washington, Report No. 3656, April 20, 1950. Experiments have been performed to study the penetration depth in superconducting Hg, Pb and Sn. Details of the preparation of colloidal specimens and the measurement of magnetic susceptibility are presented. Using relations derived from the London theory, the observations are related to the penetration depth. For Pb the penetration depth is found to be $(1{\cdot}3 \pm 0{\cdot}3)\times10^{-5}$ cm at 4·22°K. The results for Hg and Sn are discussed qualitatively. In conclusion the limitations of the colloid method for studying penetration depth are presented.

537.312.62

7904. The surface energies of superconductors. A. B. Pippard. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 3) 617–25 (1951).

Measurements of the areas of magnetization curves of superconducting colloids and films indicate that the difference between the surface energies of the normal and superconducting states at the same temperature is much smaller than has been suggested hitherto. An attempt is made to explain the high critical fields of thin films, which led to the introduction of the surface energy, by the hypothesis that a negative interphase surface energy in films favours the persistence of superconducting threads in fields higher than those normally regarded as sufficient to destroy superconductivity. A model is proposed of the interface between normal and superconducting phases which allows the interphase surface energy to be positive in pure macroscopic specimens but negative in alloys and thin films and at lattice defects. This enables a qualitative explanation to be given of some of the details, such as supercooling, of the phase transition in pure metals and alloys. A.

537.312.62

7905. Criterion for superconductivity. J. Bardeen. Letter in *Phys. Rev.*, **82**, 978–9 (*June* 15, 1951).

Some considerations for distinguishing between

interactions occurring in the normal phase and those giving rise to superconductivity. In the normal phase there is no appreciable change in effective mass or in electrical properties, whilst in the superconducting phase the electrical properties are similar to those of a metal with a small concentration of carriers of small effective mass. R. B. DINGLE

537.312.62

7906. Superconductivity of lead sulphide. J. Hatton, B. V. Rollin and E. F. W. Seymour. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 667 (*July*, 1951).

Measurements down to 1°K on two very pure specimens of natural galena by the induction method showed no signs of superconductivity.

537.312.62

7907. The interaction of lattice vibrations with electrons in a metal. G. Wentzel. Letter in *Phys. Rev.*, **83**, 168 (*July* 1, 1951).

Using perturbation theory, Bardeen [Abstr. 8751 (1950)] and Fröhlich [Abstr. 325 (1951)] have attributed superconductivity to strong interaction between the electrons and the lattice vibrations in the crystal, and hence have obtained a condition for the occurrence of superconductivity. It is now pointed out that this condition and the condition for perturbation theory to be satisfactory appear to be mutually exclusive. For an improved discussion the one-dimensional model of Bloch [*Helv. Phys. Acta*, **7**, 385 (1934)] and Tomonaga [Abstr. 3324 (1951)] is available, in which phonons and electrons are supposed to propagate in the two (opposite) directions. This model is discussed and rejected since (*a*) it appears to lead to certain complications, which are pointed out, and (*b*) no analogous description appears so far to be available for the three-dimensional case. It is concluded that the strong coupling assumption is not so far well-founded. P. T. LANDSBERG

537.312.62

7908. A difficulty in Fröhlich's theory of superconductivity. W. Kohn and Vachaspati. Letter in *Phys. Rev.*, **83**, 462 (*July* 15, 1951).

The perturbation method used in Abstr. 325 (1951) leads to divergencies when excited vibrational states are assumed for the zero-order approximation. H. LONDON

537.312.62

7909. Penetration of magnetic fields into superconductors. III. Measurements on thin films of tin, lead and indium. J. M. Lock. *Proc. Roy. Soc. A*, **208**, 391–408 (*Sept.* 7, 1951).

For Pt II, see Abstr. 7023 (1949). The magnetic moments of thin superconducting films obtained by evaporation of the metal *in vacuo*, have been measured by a ballistic method. Values of the penetration depth, λ_0, at absolute zero, derived from them by extrapolation, are estimated as $5{\cdot}0 \pm 0{\cdot}1 \times 10^{-6}$ cm for Sn, $3{\cdot}9 \pm 0{\cdot}3 \times 10^{-6}$ cm for Pb and $6{\cdot}4 \pm 0{\cdot}3$ cm for In. Within the limits of experimental error the results agree with the penetration law of London and London. From the areas of the magnetization curves, estimates of the difference in surface energy ($\alpha_n - \alpha_s$) per unit area between free surfaces of the normal and superconducting phases respectively are derived, which are smaller than those previously assumed. No evidence is found for an increase in penetration depth at low temperatures and high fields such as that suggested by the theories of Heisenberg and Koppe. A.

537.312.8 : 538.63

7910. The magneto-resistance effect in oriented single crystals of germanium. G. L. Pearson and H. Suhl. *Phys. Rev.*, **83**, 768–76 (*Aug.* 15, 1951).

Experimental measurements establish the constants involved in the dependence of the effect on orientation of magnetic field and electric current relative to the crystal axes. The measurements are internally consistent with existing phenomenological theory based on cubic crystal symmetry, in which terms involving the magnetic field to higher than the second order are neglected. It is shown that such deviations as do occur arise from higher terms in the field, since an extension of the phenomenological theory to the fourth order predicts their symmetry. Relations are established between the experimentally observed phenomenological constants and those constants appearing in existing magneto-resistance electronic theories. It is concluded that no electronic theory yet worked out is entirely consistent with experiment. The present electronic theories are special cases of a very general theory recently proposed by Shockley, and it is possible that agreement can be obtained as soon as the computational difficulties of the latter theory are overcome. A.

537.363 : 53.085.33

7911. Coordinate system for electrophoresis. V. L. Frampton and K. E. Harwell. *Analyt. Chem.*, **23**, 715–17 (*May*, 1951).

The imposition of an orthogonal co-ordinate system on the scanning negatives obtained in electrophoresis studies permits a more convenient and accurate determination of the boundary positions and of the areas occupied by the shadows. The orthogonal co-ordinate system is produced on the negative by a combination of a millimeter scale etched on the face of the electrophoresis cell and one, normal to that on the cell, etched on a glass plate that is placed immediately before the unexposed plate in the plate holder. The advantage gained is the elimination of the microcomparator and of the planimeter measurements. A.

ELECTRIC DISCHARGES 537.52

537.521 : 538.566.2

7912. Dielectric constant and electron density in a gas discharge. R. E. B. Makinson, P. C. Thonemann, R. B. King and J. V. Ramsay. *Proc. Phys. Soc., Lond. B*, **64**, 665–70 (*Aug.*, 1951).

Measurements have been made of the impedance at frequencies of the order 1 000 Mc/s of a coaxial transmission line terminating in a small electrode immersed in the plasma of a l.p. discharge in Hg vapour. The frequencies f chosen were in the neighbourhood of that for which the real part ε_1 of

the dielectric constant of the space near the electrode, as given by $\varepsilon_1 = 1 - ne^2/(\pi mf^2)$ where n is the local electron density, was near zero. The effect of making a small change in the size of the electrode was also studied. The electron density in the neighbourhood of the electrode was measured by Langmuir probes. A minimum in reactance and a maximum in resistance (when plotted against discharge current) were found to indicate $\varepsilon_1 = 0$ near the electrode, in agreement with a qualitative argument given. The possible use of such impedance measurements as a means of measuring electron density is discussed. A.

537.521 : 538.566.2

7913. Measurement of the electron density in ionized gases by microwave techniques. M. A. Biondi. *Rev. Sci. Instrum.*, **22**, 500–2 (*July*, 1951).

Methods are described in which microwave techniques are used to measure the electron density during the period following a discharge. By measuring the detuning of a resonant cavity containing electrons, it is possible to measure electron densities between 10^{10} and 10^6 electrons/cm^3 in gases whose pressure may be varied over a wide range. Design criteria are given to permit proper operation of the method under the conditions encountered in a given experiment. A.

537.523.3

7914. Negative point to plane corona—a new mode of the discharge. A. Greenwood. Letter in *Nature, Lond.*, **168**, 41–2 (*July*, 1951).

Describes a corona discharge in which a toroidal glow is located near and round the point. The gap geometry is specified. J. D. Craggs

537.523.3

7915. Corona from ice points. H. W. Bandel. Letter in *J. Appl. Phys.*, **22**, 984–5 (*July*, 1951).

Ice points of 1 and 2 mm dia., mounted 8 cm from a plane, were used in corona studies. Threshold voltages, for corona onset, with +ve and −ve points and the corresponding current/voltage curves were determined. The effect of point conductivity on the nature of the discharges is described and the difference between −ve water and ice points is ascribed to relatively efficient photo-emission in the latter case. J. D. Craggs

537.523.4

7916. Effect of weak betas on the breakdown of dielectric gaps. J. J. Suran. *Nucleonics*, **8**, 34–5 (*June*, 1951).

A mixed source of 0·65 MeV Sr^{90} and 2·16 MeV Y^{90} was used to investigate the effect of beta particles on electrical breakdown in air and solid dielectrics, between a pair of cylindrical brass electrodes 0·38 cm in dia. The beta radiation (about 2 500 mr/hr in intensity) was found to produce up to 25% reduction in the breakdown voltage in air and up to 10% reduction in solids. The greatest percentage reduction in air occurred for a gap of 0·083 in. L. R. Shepherd

537.523.4

7917. Effect of recombinations in electron avalanches. G. M. Petropoulos and P. A. Ampariotis. Letter in *Phys. Rev.*, **83**, 658 (*Aug.* 1, 1951).

For air gaps greater than 5 cm at atmospheric pressure a calculation shows that, on the assumption of a reduction of ion density by recombination, the critical length swept by electron avalanches [Abstr. 5856 (1950)] is increased. F. Llewellyn Jones

537.523.4 : 621.317.728 : 621.3.015

7918. A review of spark discharge phenomena. F. M. Bruce. *J. Brit. Instn Radio Engrs*, **11**, 121–35 (*April*, 1951).

Part I discusses the Townsend and Streamer theories on the mechanism of breakdown in gases, and their development to explain observed discharge phenomena. Certain deficiencies in both are indicated, and work in progress is mentioned which may expand the range of conditions to which Townsend's theory is applicable. Special experimental techniques to record events during the extremely short development time of a spark are mentioned. In Part II, a review is given of some observed spark gap characteristics that have to be accounted for by any comprehensive theory. Much of this work has been carried out on gaps of a type suitable for h.v. measurement, and the uniform field gap is shown to merit consideration as a standardized method of measurement. Its stable characteristics make it very suitable for the more detailed investigation of certain effects that have only a small influence on the breakdown voltage, but which may, nevertheless, be of importance in developing qualitative and quantitative theories of breakdown. The nature and objects of some investigations at present in progress along these lines are indicated. A.

537.523.5 : 621.3.014.3

7919. A technique for arc initiation. H. Edels. *Brit. J. Appl. Phys.*, **2**, 171–4 (*June*, 1951).

A method for initiating an arc discharge between fixed electrodes by an auxiliary spark discharge is discussed. Theoretical limiting values for the parameters of the initiation circuit are obtained, and these are compared with the experimental values found to be satisfactory in a circuit used for initiating a H arc. A.

537.525

7920. High-frequency discharges. I. Breakdown mechanism and similarity relationship. F. Llewellyn Jones and G. D. Morgan. *Proc. Phys. Soc., Lond. B*, **64**, 560–73 (*July*, 1951).

High-frequency breakdown between wires and coaxial cylinders in air and in H was investigated over the range of frequencies f from 3·5 Mc/s to 70 Mc/s at pressures below 20 mm Hg. It was found that geometrically similar systems broke down at the same potential provided that both parameters ap and f/p were invariant, a being a linear dimension. Under conditions such that the total amplitude of oscillation of the electron cloud was smaller than the electrode interspace, the electric field at the wire was the controlling factor, and breakdown was found to be independent of the nature of the surface of the cylinder. Consequently, secondary ionization processes did not appear to play an important part as in the case of static discharges. The experiments were in agreement with the view that the h.f. discharge in air and in H is determined by primary ionization in the gas and loss of electrons to the walls by diffusion

only, provided the electron mean free path is small compared with the linear dimension of the discharge tube, and the collision frequency is very much greater than the oscillation frequency. The significance of the similarity relation is briefly discussed. A.

537.525

7921. High frequency discharges. II. Similarity relationship for minimum maintenance potentials. F. Llewellyn Jones and G. D. Morgan. *Proc. Phys. Soc., Lond. B*, **64**, 574–8 (*July*, 1951).

The same similarity relationship which applies to breakdown applies also to the maintenance of h.f. currents, but the dependence of the minimum maintenance potential upon the parameters ap and f/p (linear dimension a, pressure p, frequency f) is not so well defined, an effect due to discharge instability. A.

537.525

7922. Gas temperatures and elastic losses in low pressure mercury-argon discharges. C. Kenty, M. A. Easley and B. T. Barnes. *J. Appl. Phys.*, **22**, 1006–11 (*Aug.*, 1951).

The increase ΔT in average gas temperature for a.c. and d.c. has been determined from measurements of the increase in pressure. A small McLeod gauge was used. Wall temperature was regulated. Corrections for end effects were made by comparing results for long and short tubes of 3·6 cm dia. Assuming the radial variation of heat input to be parabolic, the temperature distribution was calculated using published values of heat conductivity K. From the results the heat input P_m per cm length was calculated. This value was compared with the elastic loss P_e computed from electron temperature T_e and number of electrons N_e per cm column, taking into account the variation of mean free path with electron velocity. Good agreement was obtained for Hg pressures ranging from 1 to 25 microns, with the arc current 0·2–0·6 A and the A filling pressure 3·5 mm (Hg). A.

537.525 : 538.561

Plasma oscillations. *See Abstr.* 8054

537.525.5

7923. The potential field in and around a gas discharge, and its influence on the discharge mechanism. W. Finkelnburg and S. M. Segal. *Phys. Rev.*, **83**, 582–5 (*Aug.* 1, 1951).

Results on the spatial extension of cathode and anode fall regions in C arcs are reported. Potential-probe measurements reveal that the potential drop in front of either electrode is confined to $< \frac{1}{10}$ mm. The distortion of the potential field in and around any discharge, as caused by the non-uniform space charge distribution in the discharge, is discussed for the cases of a low-current C arc and a negative point corona; for the latter case use was made of data by Loeb. The potential field distortions result in radial electric fields which, depending on their polarity, seem to hinder or support the radial expansion of the discharge. Potential-probe measurements in low- and high-current arcs are in good agreement with this theoretical analysis and prove the transitional region between the distorted potential field in the arc and the undistorted potential field outside of the discharge to be a fairly thin one. A.

537.525.72

7924. The role of a positive column in the reduction of current due to external light in an electrodeless discharge. V. V. Agashe. *J. Chem. Phys.*, **19**, 1002–6 (*Aug.*, 1951).

The discharge current in a cylindrical tube (45 mm dia. and 45 mm long) with external electrodes decreases on exposure to external light. An attempt has been made to determine the contribution to the reduction in current, by the different regions of the discharge tube, by exposing equal volumes of the discharge tube, one after another, from one electrode to the other. In the studies of Hg vapour discharge, the intensity and the source of the irradiation are changed and the pressure of Hg vapour is kept constant, while in the studies of Cl_2 discharge, the intensity and the frequency of irradiation are kept constant and the pressure of Cl_2 is changed from 3 mm to 70 mm of Hg. The results show that the reduction in current is maximum when the positive column of the discharge tube is exposed to external light. It has been suggested that a few more electrons in the positive column are lost by the formation of negative ions under the influence of external light. This reduces the average velocity of negatively charged particles and is probably responsible for the observed decrease in current. A.

537.525.8

7925. Radiation of the plasma of the glow discharge in moist air. K. S. Garger. *J. Tech. Phys., USSR*, **20**, 1413–21 (*Nov.*, 1950) *In Russian.*

Spectral investigation of the radiation of the positive column of the glow discharge in air with an admixture of water vapour from 10^{-5}% H_2O to 50% H_2O in the wavelength range 2 800–7 300 Å (continuum) for vapour pressures from 0·5–40·0 mm Hg-column and at currents 0·5–10·0 mA. The high sensitivity of the relative intensity of the H_α-line, and the adjacent bands of the first positive system of N, to moisture enabled the development of a method of determining vapour admixtures to the air at reduced and normal pressure. The limits of reliable determination are 0·02–2·0% H_2O, with an error margin of 4–10%. The relation between the relative intensity of the line H_α and the N_2 bands, and pressure of the mixture, slot width and current, respectively, was investigated. It may be assumed as a result of the investigation of the spectra of the discharge that the vapour dissociates into atomic H and hydroxyl, and that the O appears only by secondary processes. In the processes of the H_2O dissociation and excitation of H the metastable molecules $N_2(A^3\Sigma)$ play an important role. Some possible applications of the results obtained are discussed. B. F. Kraus

X-RAYS 537.531

537.531 : 535.3 : 535.343–32

7926. Some comparison between X-ray and ultraviolet absorption in different tissue and cell structures. A. Engström. *Disc. Faraday Soc., No.* 9, 427–31 (1950).

The results from investigation of a number of

tissues and cells by an X-ray absorption technique for the determination of mass of cell structures are presented. The variations in density in different structures are compared with the absorption of u.v. light. Attention is drawn to errors inherent in the experimental material and influencing the accuracy of the results. A.

537.531 : 535.33

7927. The fine structure of *K*-series X-ray emission spectra of the elements Mn (25)–Zn (30) and Ge (32). I. Edamoto. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 561–612 (*Aug.*, 1950).

The fine structure of the X-ray emission spectra K_α and K_β, obtained by bent crystal spectrographs, of the elements Mn^{25}–Zn^{30} and Ge^{32}, were microphotometrically investigated, and the wavelengths of many weak lines have been determined. The measurement of the intensity distributions of these spectra was also carried out by the photogram-microphotometer method, and it has been confirmed that the accuracy of the results is comparable to that obtained by the double crystal spectrometer. Next, resolutions of the lines K_{α_1}, K_{α_2} and $K_{\beta_{1,3}}$ into their component lines were tried and it has been shown that the structures of these lines have some correlation with one another. The use of the net planes which give rise to reflections of large dispersion and an auxiliary lens which reduces the photographic grain effect on the microphotometric curve facilitated the experiment. A.

537.531 : 535.343.2

7928. Theory of the temperature dependence of the fine structure of X-ray absorption spectra of solids. A. L. Kostarev. *J. Exp. Theor. Phys., USSR*, **20**, 811–23 (*Sept.*, 1950) *In Russian.*

An investigation is made of the influence of the thermal vibrations of surrounding atoms on the elementary act of the *K* X-ray absorption in solids. From this point a theory of the temperature-dependence of the fine and superfine absorption structure is developed. Calculations are made of the temperature boundaries for the disappearance of the fine and superfine structure in a particular case of crystalline Cu. Theoretical conclusions are in sufficiently good agreement with the experiment.

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537.531 : 535.36

7929. Penetration and diffusion of X-rays. Calculation of spatial distributions by polynomial expansion. L. V. Spencer and U. Fano. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 446–56 (*June*, 1951).

The expansions of the spatial distribution of X-rays in suitable systems of polynomials appear to converge rapidly. Calculations are performed for various source geometries in an infinite homogeneous medium up to 10 to 15 mean free paths of the primary radiation. The surprisingly good convergence of this method of calculation is discussed with a view to its possible use in a variety of problems. A.

537.531 : 535.42

7930. X-ray shadow microscope. V. E. Cosslett and W. C. Nixon. *Nature, Lond.*, **168**, 24–5 (*July* 7, 1951).

Describes an instrument in which the X-ray focal spot is about 1μ in size. This size is achieved by the use of magnetic "demagnification." The apparatus can also be used as a fine-focus tube for X-ray analysis. Typical shadowgraphs are reproduced. J. THEWLIS

537.531 : 621.386.1

7931. New X-ray diffraction tubes of high brilliance. K. Drenck and R. Pepinsky. Letter in *Rev. Sci. Instrum.*, **22**, 539–40 (*July*, 1951).

One tube uses an electron gun and magnetic focusing, giving a focal spot of dia. 30 micron with a current of 0·3 mA at 35 kV. The other has a pin-shaped target and a ring-shaped cathode around it; it can pass 0·3 mA steady current at 35 kV or can be used for pulsed operation. A. R. STOKES

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 621.384.61

7932. The Yale linear electron accelerator. H. L. Schultz and W. G. Wadey. *Rev. Sci. Instrum.*, **22**, 383–8 (*June*, 1951).

The principles and preliminary operation of an accelerator designed to produce large currents of 10 MeV electrons are described. Independent resonant cavities operating in the TM_{010} mode are used. The early cavities are designed to give both phase and radial focusing over a useful fraction of the acceleration cycle, electrons being injected at 5 kV. A master-oscillator controls eight triode power amplifiers each feeding 500 kW peak at 600 Mc/s for 10 μsec up to 90 times/sec into a single cavity, the phases being separately adjustable. Mean currents of 0·2 μA at 1·7 MeV are readily obtained at reduced input, and peak energies up to 4 MeV have been obtained, but tube failures have so far prevented full-power operation. J. H. FREMLIN

537.533 : 621.385.833

7933. An electronic ram. W. Raudorf. *Wireless Engr*, **28**, 215–21 (*July*, 1951).

A simple method for accelerating electrically-charged particles is suggested, based on the transfer of the energy of a moving electric charge to a small fraction of that charge. A tubular arrangement is described in which the axial velocity of an electron beam is controlled by a longitudinal magnetic field. The beam is suddenly decelerated on entering a zone of rapidly increasing magnetic-field intensity, as a consequence of which a potential barrier arises at the front of the beam. Electrons beyond this barrier become accelerated in the induced electric field. An extremely short and powerful e.m. pulse is generated. A.

537.533.7

7934. On the Cherenkov radiation. T. Taniuti. *Progr. Theor. Phys.*, **6**, 207–15 (*March–April*, 1951).

A classical and a quantum mechanical theory of the Cherenkov radiation is given. P. T. LANDSBERG

537.533.72

7935. On the general properties of weak electron lenses: the first approximation. F. Bertein. *J. Phys. Radium*, **12**, 595–601 (*May*, 1951) *In French.*

If the e.s. field on either side of a defining aperture

is different, there will be a focusing action which it is evidently necessary to know over the whole aperture. The lens is treated as perfectly thin. Its mean convergence is defined as the relative reduction in cross-sectional area of a beam on passing through it. This is shown to $\propto$ the difference of field on each side and, to the approximation considered, to be uniform all over the aperture. Several simple cases are discussed, including an astigmatic corrector of zero mean convergence. To the same approximation, all weak thin magnetic lenses (i.e. field discontinuities) have zero mean convergence. J. C. E. JENNINGS

537.533.72

7936. A demonstration apparatus for electron optics. C. FERT. *C.R. Acad. Sci., Paris*, **232**, 2085–7 (*June* 4, 1951) *In French.*

A brief description of a demountable cathode-ray tube with a number of diaphragms and lenses which permit various electron optical systems to be demonstrated. A. H. W. BECK

537.533.72

7937. A high resolution two-directional focusing beta-ray spectrometer. A. A. BARTLETT AND K. T. BAINBRIDGE. *Rev. Sci. Instrum.*, **22**, 517–23 (*July*, 1951).

A large beta-ray spectrometer based on the theory worked out by Siegbahn, Svartholm and others has been constructed. The magnet design is unique in that the return path in iron for the gap flux is provided by a circumferential yoke rather than by an axial core. The mean radius of the electron orbits is $r_0 = 30$ cm and the maximum acceptable solid angle with present diaphragms is 0·8% of a sphere. Construction is discussed and data are presented to show the resolution to be approximately 0·4% under these conditions. A.

537.533.72 : 621.385.833

7938. Theory of electrostatic lens with central elliptical aperture. E. REGENSTREIF. *C.R. Acad. Sci., Paris*, **232**, 1918–20 (*May* 21, 1951) *In French.*

Explicit formulae are given for deriving the Gaussian trajectories of electrons passing through an infinitely thin 3-electrode electrostatic lens, the central electrode having an elliptical aperture. H. J. H. STARKS

537.533.74

7939. Cloud chamber study of the scattering of positrons by electrons. O. RITTER, C. LIESEBERG, H. MAIER-LEIBNITZ, A. PAPKOW, K. SCHMEISER AND W. BOTHE. *Z. Naturforsch.*, **6a**, 243–9 (*May*, 1951) *In German.*

A track length of 2 900 m for Cu^{64} positrons in methane at atmospheric pressure enabled the scattering frequency for energies between 100 and 400 keV to be determined in a "slow expansion" cloud chamber (new model described) and compared with the theory of Möller and Bhabha. Agreement is good. A three-particle encounter of a positron and two electrons was recorded. J. G. WILSON

537.533.74

7940. On the back scattering of electrons. G. CHARPAK AND F. SUZOR. *C.R. Acad. Sci., Paris*, **232**, 2308–9 (*June* 18, 1951) *In French.*

Refined experiments showed that, contrary to previous measurements [Abstr. 3734, 3735, 4443 (1951)], the back scattering of the β-rays of S^{35}, Co^{60} and P^{32} and of the electrons from Tc^{99m} is similar. J. HUGHES

537.533.74 : 778.34

7941. Observations on the multiple scattering of ionizing particles in photographic emulsions. II. The scattering of positrons at 105 and 185 MeV. M. G. K. MENON, C. O'CEALLAIGH AND O. ROCHAT. *Phil. Mag.*, **42**, 932–51 (*Aug.*, 1951).

The co-ordinate method has been used to measure the multiple scattering in Ilford G5 emulsions of positrons of nominal energy 113 and 196 MeV. The energies of the positrons corrected for loss by ionization and radiation are calculated to be 105 and 185 MeV respectively. The experimental distributions of second differences have been compared with those predicted by the theory of Molière [Abstr. 3225 (1947), 609 (1949)] and the agreement found to be very satisfactory. Methods of minimizing the effects of spurious scattering and of taking into account the influence of distortion are discussed. Values are found for the scattering constant which are in good agreement with those calculated from the theory of Molière. A discussion of these results has been given in the previous Part [Abstr. 7954 (1951)]. A mathematical treatment is given in the Appendices: the correlation existing between successive second differences; the distribution of second differences when measured in the presence of spurious scattering; and a possible method for correcting second differences which have been affected by a large-angle scattering. A.

537.533.8

7942. Secondary emission of electrons from liquid metal surfaces. J. J. BROPHY. *Phys. Rev.*, **83**, 534–6 (*Aug.* 1, 1951).

The secondary emission ratio as a function of primary energy is determined for targets of Bi, Ga, Pb and Hg for the metals in both the liquid and solid state. The secondary emission characteristics for liquid surfaces are shown to be very nearly like those for solid surfaces and in general the shape of the secondary efficiency curves for these materials are similar to those for other pure metals. A comparison of the observed maximum secondary ratios with predicted values is made. A.

537.533.92 : 548.7 : 539.27

Study of ionic crystals under electron bombardment. *See Abstr.* 8253

537.534

7943. The potential field of duants ["dees"]. I. A. M. STRASHKEVICH. *J. Tech. Phys., USSR*, **19** (*No.* 1) 132–3 (1949) *In Russian.*

See *Phys. Rev.*, **53**, 408–20 (*March* 1, 1938). For separations ($2k$) of the dees $> 0{\cdot}4$ times their height ($2h$), the potential function, in terms of suitably transformed co-ordinates, may be expressed as the sum of a series of zero-order Bessel functions of the first kind. J. C. E. JENNINGS

537.534

7944. The potential field of duants ["dees"]. II. V. M. GAVRILYUK AND A. M. STRASHKEVICH. *J. Tech. Phys., USSR*, **20** (*No.* 10) 1241–4 (1950) *In Russian.*

See preceding Abstr. Using the Schwarz–Christoffel

transformation, an expression has been obtained for the potential function, valid for any k/h. Results are compared with experimental ones of Wilson [*Phys. Rev.*, **53**, 408–20 (*March* 1, 1938)]. In the central plane the formula for the field strength reduces to a form identical to that given by Rose [*Phys. Rev.*, **53**, 392–408 (*March* 1, 1938)]. Graphs are given for $k/h = 0{\cdot}4$ and 1. J. C. E. JENNINGS

537.534

7945. On resonance damping at injection in betatrons and synchrotrons. S. E. BARDEN. *Proc. Phys. Soc., Lond. B*, **64**, 579–90 (*July*, 1951).

It is shown that under special conditions of injection, damping of electron oscillations can occur in "imperfect" cyclic accelerators, i.e. those with an azimuthally inhomogeneous electromagnetic field, in the presence of resonance between their different periodic motions. This mechanism is invoked to explain the successful injection of electrons in most betatrons and synchrotrons. The necessary coupling inhomogeneity to induce resonance damping at injection can be created by the large currents circulating during this period in the acceleration cycle. A.

537.534

7946. Multiple traversal of cyclotron targets. J. M. CASSELS, J. M. DICKSON AND J. HOWLETT. *Proc. Phys. Soc., Lond. B*, **64**, 590–4 (*July*, 1951).

In high-energy cyclotrons the accelerated particles may pass through the target more than once. The average number of traversals is calculated theoretically and compared with experimental results. Good agreement is found. A.

537.534.72

7947. The aperture defect in the ion-optical imaging of a point by means of an arbitrarily bounded magnetic field. H. HINTENBERGER. *Z. Naturforsch.*, **6a**, 275–6 (*May*, 1951) *In German.*

An expression for the aperture defect is given following earlier work [*Z. Naturforsch.*, **3a**, 125 (1948) and Abstr. 4816 (1949)]. A. H. W. BECK

537.534.72

7948. Ionic optics, ion focusing in the mass spectrometer. F. BERTEIN. *Bol. Radiactividad*, **23**, 86–100 (1950) *In French.*

Description of mass spectrometers with a short discussion of the magnetic separation of the ions, their separating power, aberrations and double focusing. A.

537.534.72

7949. Construction of gaseous and electric spectrometer circuits. F. BERTEIN. *Bol. Radiactividad*, **23**, 101–16 (1950) *In French.*

Describes the practical construction of spectrometers and the problems of ion sources, acceleration, collection, graphic registration and vacuum system, discussing by analogy between gaseous and electrical circuits. A.

537.534.72

7950. The application of mass spectrometry to radioactivity and chemistry. F. BERTEIN. *Bol. Radiactividad*, **23**, 117–34 (1950) *In French.*

Discusses localization of leaks, determination of masses and isotopic abundance, the use of the isotopic indicators in chemistry, nuclear reactions, the separation of the isotopes, metastable ions and appearance potentials. A.

537.534.72 : 537.591.08

7951. The formula for the mass-spectrometer of Alikhanov and Alikhanyan. V. A. KRAVTSOV. **Reply to V. A. Kravtsov's letter.** A. VAĬSENBERG, V. MOROZOV AND A. KHRIMYAN. *J. Exp. Theor. Phys., USSR*, **20**, 1054–5 (*Nov.*, 1950) *In Russian.*

See Abstr. 3297 (1949).

537.534.72 : 539.172.13

Excitation functions with an internal cyclotron beam. *See Abstr.* 8187

537.534.74 : 539.17

7952. Compound scattering of protons and deuterons. T. HUUS. *K. Danske Vidensk. Selsk. Mat.-fys. Medd.*, **26** (*No.* 4) 14 *pp.* (1951).

The angular distributions of protons and deuterons in the range 0·5–2·0 MeV, scattered by Be, Cu and Au foils, were determined using a deflection chamber in which the scattered particles were swept over a narrow collector by means of an oscillating magnetic field. The varying output from the collector and the current in the coils generating the magnetic field were fed to the X and Y plates of an oscillograph in such a way that the trace on the screen gave directly the angular distribution curve. The results agree well with the theory of compound scattering [Bohr, Abstr. 2554 (1949); Williams, *Proc. Roy. Soc. A*, **169**, 531 (1939), *Phys. Rev.*, **58**, 292 (1940).

W. J. SWIATECKI

537.534.74 : 778.34

7953. Discussion of a measurement of multiple Coulomb scatter. C. MABBOUX. *C.R. Acad. Sci., Paris*, **232**, 2309–11 (*June* 18, 1951) *In French.*

A method of determining the small-angle scatter constant from observations on tracks due to charged particles of high energy in photographic emulsions is briefly described. A. C. COATES

537.534.74 : 778.34

7954. Observations on the multiple scattering of ionizing particles in photographic emulsions. I. The value of the scattering constant. K. GOTTSTEIN, M. G. K. MENON, J. H. MULVEY, C. O'CEALLAIGH AND O. ROCHAT. *Phil. Mag.*, **42**, 708–21 (*July*, 1951)

The theories of multiple scattering of Williams, Molière, Snyder and Scott are briefly surveyed. The results of five independent determinations of the scattering constant for G.5 nuclear research emulsions, details of which are to be presented in the following papers, are compared and discussed. The constant has been found to vary with cell-size and β in a manner which is in agreement with theory. The effect of rejecting large angles due to plural scattering is considered, and also those errors which arise from the presence of spurious scattering. [For Pt II, see Abstr. 7941 (1951)]. A.

537.534.72

7955. The range and straggling of protons between 35 and 120 MeV. N. BLOEMBERGEN AND P. J. VAN HEERDEN. *Phys. Rev.*, **83**, 561–6 (*Aug.* 1, 1951).

The range of protons in Al, Cu and Pb has been

determined with a photographic method, using the internal beam of the 95 in synchrocyclotron of Harvard University. The method allows the simultaneous determination of the range, straggling, and the energy distribution of the protons in the internal beam. The latter was shown to have a half-width of 12 MeV. The experimental results for the range show slight, but significant, deviations from tabulated values. Results for the straggling agree well with theory, if the effect of multiple scattering in the absorber is taken into account. A.

537.534.75

7956. The absolute energy loss of 18-MeV protons in various materials. D. C. SACHS AND J. R. RICHARDSON. *Phys. Rev.*, **83**, 834–7 (*Aug.* 15, 1951).

The absolute energy loss of 17·77 ± 0·03 MeV protons upon passing through various materials was measured using a 41 in f.m. cyclotron. A ribbon foil of Th, mounted inside the dee, was used to deflect the circulating proton beam above the median plane of the cyclotron magnetic field. This scattered beam of protons, confined to a plane above the median plane, described a circular path in the magnetic field through a slit system. At the 180° point, the beam was made to pass through a thin metallic foil. The protons travelled an additional 210° to an ionization chamber detector. It was possible to move the detector to different cyclotron radii. The displacement of the proton intensity distribution caused by the presence of the metallic foil was a measure of the absolute energy loss in the foil. It was possible to calculate the stopping power and the mean excitation potential for each material investigated. The results for Al yield a value of 156 ± 3 electron volts for the mean excitation potential. Other materials examined included Ni, Cu, Rh, Ag, Cd, Sn, Ta, Au and Nylon. Some information was obtained concerning the corrections to be applied to the stopping power formula; hence, the variation of these corrections with the atomic number of the stopping material was determined. A.

537.534.75 : 778.34

7957. On the range-energy relation of low energy protons and α-particles in a photographic emulsion. L. NATANSON. *Acta Phys. Polon.*, **10** (*No.* 3–4) 280–3 (1951).

The lengths of tracks of tritons and α-particles produced in the reaction $Li^6(n, \alpha)H^3$ have been measured in Ilford "Nuclear Research" emulsion C2, and the results of these measurements have been compared to those values which should be expected from Rotblat's range-energy curves. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 621.381.61 : 621.317.713

7958. Millimicroampere current integrator for a cyclotron. R. J. WATTS. *Rev. Sci. Instrum.*, **22**, 356–9 (*June*, 1951).

A low-current integrator is described using a very-low-leakage 0·001 μF capacitor discharged by means of two electrometer tubes in parallel. These are normally biased to − 30 V, when leakage is negligible over many hours. The capacitor is directly connected to the grid of a third electrometer tube forming the first stage of a d.c. amplifier whose output operates a relay to discharge the capacitor. For very small currents a master switch is described enabling associated equipment to be turned on and off on selected discharge pulses. Measurements show that stability is adequate and leakage negligible. J. H. FREMLIN

537.542

7959. A new principle for an ion source of high intensity. J. SOMMERIA. Letter in *J. Phys. Radium*, **12**, 563–4 (*April*, 1951) *In French.*

An extension of the Heil–Von Ardenne type to an annular system; an ion current of ~ 1 mA was extracted from a 1 cm² opening for an electron current of 10 mA. J. HUGHES

537.542

7960. The dependence of the efficiency of Geiger–Müller counters for gamma rays upon the wall thickness. M. SUFFCZYŃSKI. *Acta Phys. Polon.*, **10** (*No.* 3–4) 270–3 (1951).

This dependence was investigated for brass and lead walls with γ-rays of Ra and MsTh filtered through 2 or 3 cm Pb. The curves of the relative efficiency of the counters versus wall thickness were found to be typical "transition curves" with flat maxima shifting towards greater thicknesses with increasing energy of the incident photons. A.

537.542

7961. A Geiger–Müller photo-counter, with Fe/Ni cathode for u.v. radiation. J. LABEYRIE. Letter in *Phys. Radium*, **12**, 569–70 (*April*, 1951) *In French.*

Gives operating data, e.g. sensitivity and spectral variations of response for a Geiger counter sensitive to radiations lying mainly between 2 000 and 3 200 Å. The response of an R.C.A. 1P28 photomultiplier tube is given for comparison. J. D. CRAGGS

537.542

7962. On the temperature effects of spurious counts in Geiger–Mueller counters. M. KIMURA. *J. Phys. Soc. Japan*, **6**, 141–8 (*May–June*, 1951).

The temperature effect was observed when the counters were heated and cooled at constant rates. During the heating stage, the rate of natural counts increased in various manners which depended on the filling gases and on the cathode material, and decreased rapidly during the cooling stage without exception. It was verified that these discharges were due to the so-called "Spontanentladung" of Trost and the occurrence of the double or triple discharges (Nachentladung) was very small. The counts decreased exponentially with the square root of time when the counter was kept at constant temperature near 100°C. Tentative explanation can be made along the lines of so-called Malter effect of the thin oxide film of the cathode. But the effect of adsorption and evaporation of the quenching gas molecules and also the negative ions at the cathode surfaces cannot be neglected. A.

537.542 : 537.531

7963. Improved counting rate meter for X-ray measurement. G. Shinoda and T. Tomura. *J. Phys. Soc. Japan*, **6**, 148–52 (*May–June*, 1951).

The advantages of this counting rate meter are as follows: (1) statistical fractional standard deviations are constant throughout whole range of $1 : 10^4$, (2) probable errors are also made constant by means of logarithmic scale, (3) the time required for reading is shorter at higher counting rates, and (4) therefore it is advantageous for measuring the counting rate from natural counting to saturation counting with probable error less than 3%, using 0·8% accuracy meter and with only one scale. A.

537.542 : 621.387.424

7964. The gas-filling and some characteristics of bromine-quenched Geiger–Müller counters. D. H. Le Croissette and J. Yarwood. *J. Sci. Instrum.*, **28**, 225–8 (*Aug.*, 1951).

The preparation of Geiger–Müller counters containing Br_2 as a quenching gas in a filling of Ne and/or A is described with particular attention paid to ensuring that the partial gas pressures are determined accurately. An empirical law relating the threshold voltage and the partial pressure of Br_2 is obtained. The true function of a small percentage of A in a Ne–Br_2 counter as regards its effect on the length of the plateau is considered. Some new data appear on the oscillations produced by these counters. A.

537.542

7965. The design of thin windowed Geiger–Müller counters. R. L. Purbrick, L. T. Cherry and J. F. Carpenter. *Rev. Sci. Instrum.*, **22**, 482–4 (*July*, 1951).

The optimum length of an end-window counter for the measurement of weak C^{14} activities is found to be about 1 cm. A.

537.542

7966. The calculation of the geometrical efficiency of end-window Geiger–Müller tubes. E. Berne. *Rev. Sci. Instrum.*, **22**, 509–13 (*July*, 1951).

Integrals for the calculation of the solid angle of a plane disk in respect to the window of an end-window Geiger–Müller tube have been derived. Numerical values for a window diameter of 30 mm have been computed. A.

537.542 : 621.387.424

7967. A multiple-anode anticoincidence ring counter. C. H. Raeth, B. J. Sevold and C. N. Pederson. *Rev. Sci. Instrum.*, **22**, 461–3 (*July*, 1951).

An annular Geiger–Müller counter with six anodes has been built as a replacement for the usual six-tube charged particle shielding ring in a cosmic-ray anticoincidence bundle. The counter has uniform pulse heights and starting voltages on all anodes, and a slightly higher shielding efficiency than the six-tube ring. A.

537.542

7968. A survey-meter for soft betas in air. S. Block. *Nucleonics*, **8**, 51–4 (*April*, 1951).

A large-volume ($\sim 7\,750$ cm^3), lucite ionization chamber is employed with a quartz-fibre electrometer. In operation the chamber is first evacuated and the air sample is then allowed to enter over a drying agent. Ionization is measured by the rate of discharge of the electrometer and chamber. Calibration of this apparatus with known $C^{14}O_2$ samples is described. The lower limit of sensitivity is $\sim 10^{-7}$ μc/cm^3 of this gas. L. R. Shepherd

537.542

7969. A comparison of the experimental and computed fast neutron efficiencies of a scintillation counter. G. E. Owen, J. Neiler and W. Ray. Letter in *Phys. Rev.*, **83**, 674 (*Aug.* 1, 1951).

Using a 1 in cube of anthracene and a PoBe neutron source, computed and experimental bias curves are obtained which show mutual agreement after correction for γ-ray counts present. G. F. J. Garlick

537.542 : 621.387.464

7970. Nuclear scintillation counters. J. B. Birks. *J. Brit. Instn Radio Engrs*, **11**, 209–23 (*June*, 1951).

A short review of recent developments. A. O. Stanesby

537.542 : 621.316.722.9

7971. General theory of voltage stabilizers. J. J. Gilvarry and D. F. Rutland. *Rev. Sci. Instrum.*, **22**, 464–8 (*July*, 1951).

For abstract, see Abstr. 3717B (1951).

537.542 : 621.318.572

7972. New type counting-rate recorder. H. O. Anger. *Nucleonics*, **8**, 76–9 (*Feb.*, 1951).

Counter pulses feed into a scaling circuit which operates a high-speed relay. Each operation of the relay charges a small condenser to a fixed voltage and then discharges it into a large reservoir condenser. Thus the potential across the large condenser is a measure of the number of times the relay has operated. The reservoir condenser is switched on to a recording millivoltmeter and then discharged at fixed intervals determined by a rotating cam. L. R. Shepherd

537.542 : 621.318.57

7973. A comprehensive counting system for nuclear physics research. I. Basic system and synthesis of simple instruments. N. F. Moody, W. D. Howell, W. J. Battell and R. H. Taplin. *Rev. Sci. Instrum.*, **22**, 439–42 (*July*, 1951).

A majority of nuclear measurements involve digital pulse counting so that the associated instruments have many common functions. The counting systems fall into two broad classes: Those in which all pulses exceeding a certain threshold are summed; and more complex analysing procedure wherein pulses must be classified according to amplitude or temporal distribution. Such instruments may be synthesized from a common group of sub-units, and these are outlined and listed on a functional basis. While the utility of the sub-units is evidently determined by their versatility, they are in addition required to have high reliability in order that complex assemblies may give satisfactory service. Design for long life follows naturally from the latter consideration. The paper shows the manner in which the simpler instruments can be synthesized, and outlines the more complex automatic counting and analysing systems possible

The construction of a range of scalers is illustrated and their performance specifications and photographs are shown. A.

537.542 : 621.319.5

7974. A synchronized high voltage pulse generator. C. F. JOHNSON. Letter in *Rev. Sci. Instrum.*, **22**, 541 (*July*, 1951).

A charged capacitor is discharged via a thyratron through the primary of a car ignition coil, across the secondary of which the pulse is produced. The discharge is produced by removal of the bias from the thyratron. R. DAVIS

537.542 : 621.318.572

7975. A mechanical kick-sorter (pulse size analyser). S. G. F. FRANK, O. R. FRISCH AND G. G. SCARROTT. *Phil. Mag.*, **42**, 603–11 (*June*, 1951).

This instrument serves to obtain the size distribution of electric pulses coming, for example, from an ion chamber or counter. Each pulse causes a small steel ball to be propelled along an inclined board; the ball describes a parabolic path and lands in one of 30 parallel grooves. As balls accumulate in the grooves a histogram of the pulse size distribution is built up. The mechanical construction and the associated electronic circuits are described. The latter serve, among other things, to eliminate pulses which are either too large or too small to be recorded, or which follow too close upon the last recorded pulse. A.

537.542 : 621.389 : 621.318.572

7976. A high precision pulse height analyser of moderately high speed. G. W. HUTCHINSON AND G. G. SCARROTT. *Phil. Mag.*, **42**, 792–806 (*July*); *erratum, ibid.*, 957 (*Aug.*, 1951).

A pulse height analyser is described suited particularly to the requirements of nuclear physics. Information is stored in a supersonic delay-line and displayed on a cathode-ray tube. The accuracy of channel width and the linearity of response are both one part in a thousand. The number of channels and storage capacity per channel may be varied at will to give 60 channels of up to 10^6 pulses, 80 channels of up to 3×10^4 pulses, or 120 channels of up to 1 032 pulses. The maximum counting rate is 1 600 per sec. [The erratum corrects the text of the circuit description in the appendix; the diagrams are correct.] A.

537.542 : 621.395.62

7977. A design of an ultrasonic delay-line. T. GOLD. *Phil. Mag.*, **42**, 787–91 (*July*, 1951).

A simple design of a vertical folded Hg delay-line is described. The device is used as a memory unit for electronic apparatus, where it introduces a delay of 1·2 msec with a bandwidth of several Mc/s. Design considerations and essential delays of construction are given, and the operating conditions are mentioned. A.

537.542/.543

7978. The effect of temperature on counters and radio tubes. A. DAUDIN AND J. DAUDIN. Letter in *Phys. Radium*, **12**, 564 (*April*, 1951) *In French.*

It was found that while Maze type counters with an argon/methyl alcohol filling were not affected, the characteristics of the amplifying tubes used (6J7 and EF51) were considerably changed by temperatures in the range + 20° to − 20°C.

J. HUGHES

537.543 : 621.385.16.029.6

7979. The space charge in a magnetron in the static regime of cut off; cylindrical magnetron. J.-L. DELCROIX AND G.-A. BOUTRY. *C.R. Acad. Sci., Paris*, **232**, 1653–5 (*April* 30, 1951) *In French.*

Briefly quotes certain formulae relating to electron space-charge effects (space-charge densities, potential distributions, etc.) in magnetrons. J. D. CRAGGS

IONIZATION . THERMIONICS 537.56/.58

537.568

7980. Ionization of argon atoms by helium or neon metastable atoms. M. A. BIONDI. Letter in *Phys. Rev.*, **83**, 653 (*Aug.* 1, 1951).

Cross-sections for ionization of A by metastable He or Ne atoms are derived from microwave measurements of electron densities. Results for Ne do not agree with those derived by Kruithof and Druyvesteyn from sparking potential measurements.

F. LLEWELLYN JONES

537.568 : 539.132

7981. Concerning the mechanism of electron-ion recombination. M. A. BIONDI AND T. HOLSTEIN. Letter in *Phys. Rev.*, **82**, 962–3 (*June* 15, 1951).

Dissociative recombination [Abstr. 5075, 6588 (1950)] can explain the experimental results [Abstr. 4815 (1949), 2527 (1950), 1865 (1951)] if metastable high vibration states are postulated. J. JACOBS

537.58

7982. Thermal ionization of calcium and determination of specific charge of Ca^+. A. S. BHATNAGAR. *Proc. Nat. Acad. Sci. India, Sect. A*, **16** (*No.* 2) 45–51 (1947).

The thermal ionization of Ca has been studied using the vacuum graphite furnace constructed by Saha and Tandon. The specific charge of Ca^+ has been determined by applying the space charge theory to positive currents under various potentials [see Abstr. 7983 (1951)]. The contribution of the terms $b(T)$ and $b'(T)$ for Ca in the ionization formula tends to lower the effective ionization potential. The mean value of the energy of ionization is 136·9 kcal. The value of the specific charge of Ca is $7\cdot5\times10^{12}$ e.s.u./g. A.

537.58

7983. Thermal ionization of lithium and determination of specific charge of Li^+. B. N. SRIVASTAVA AND A. S. BHATNAGAR. *Proc. Nat. Acad. Sci. India, Sect. A*, **15** (*No.* 5–6) 175–87 (1946).

The apparatus employed in earlier experiments [*ibid.*, **14**, 106, 118 (1944)] has been used to investigate the thermal ionization of Li. The effusion currents have been measured with and without the magnetic field at various accelerating voltages for both positive and negative particles. The space charge theory

developed in a previous paper [*Proc. Nat. Acad. Sci. India*, **15**, 165 (1946)] for unipolar currents has been applied to the experimental data on the positive current under magnetic field. The value of e/m for the positive particle has been thereby determined. Calculations show that the simple unipolar theory for a bicomponent mixture as developed here is not applicable to the negative currents. The saturation currents are also measured and the energy of ionization of Li determined with the help of the ionization formula. The ionization potential is 5·35 V, and the value of e/m for Li^+ is found to be $3\cdot3\times10^{13}$ e.s.u./g. A.

537.58

7984. Thermal ionization of aluminium and determination of the specific charge of Al^+. A. S. Bhatnagar. *Proc. Nat. Acad. Sci. India, Sect. A*, **16** (*No.* 3) 53–9 (1947).

The thermal ionization of Al has been studied employing the vacuum graphite furnace constructed by Saha and Tandon. The problem is experimentally more difficult than for other elements due to the low vapour pressure and large ionization potential of aluminium, and has necessitated some modification in the usual experimental arrangement. The mean value of the energy of ionization is found to be 135·9 kcal. Following the method developed in the paper on Li [Abstr. 7983 (1951)] the e/m for Al^+ has also been determined by applying the space charge theory to unipolar positive current produced by Al^+ ion. The value obtained is $1\cdot22\times10^{13}$ e.s.u./g. A.

537.583

7985. On the initial decay of oxide-coated cathodes. T. Hibi and K. Ishikawa. Letter in *J. Appl. Phys.*, **22**, 986–7 (*July*, 1951).

Experiments on the decay of emission during times of $\simeq \frac{1}{10}$ sec are described. It was found that holding the cathode at 1 250°K for one hour decreased the decay effects. It was subsequently found that if the getter splash was cooled during this heating the decay phenomena were unaltered. It is thought that warming the getter increases the absorption of gas and therefore that long period decays are due to gas poisoning. A. H. W. Beck

537.583 : 539.16

7986. Influence of radioactivity on the thermionic emission from cathodes. J. Debiesse, G. Neyret, J. Challansonnet and J. Amoignon. *C.R. Acad. Sci., Paris*, **232**, 2015–16 (*May* 28, 1951) *In French.*

Cathode sleeves of Ni + 5% Co alloy were made radioactive by pile bombardment. Cathodes made on these sleeves showed much higher work functions than similar cathodes on untreated alloy. Clean, uncoated W which had been subjected to neutron bombardment also showed much less emission than untreated W. A. H. W. Beck

537.583 : 621.385.032.216

7987. Thoria as a cathode emitter. W. E. Danforth. *J. Franklin Inst.*, **251**, 515–20 (*May*, 1951).

This paper outlines the cathode characteristics of thoria which lead to its selection in certain cases where the BaO–SrO cathode is unsuitable. Dependable values of pulsed thermionic emission of 4 A/cm² at 1 600°C and 14 or 15 A/cm² at 1 800°C are available. The decay of emission with time is much less rapid than with BaO–SrO, the time constants being $\sim\frac{1}{10}$ sec. Maximum d.c. emission, that is, equilibrium emission after decay, is found to be between 1 and 5 A/cm². Although when compared to BaO–SrO the activation phenomena are not prominent, it is found that the same essential pattern exists. For use in pulsed applications the life of a thoria-coated cathode is determined by its evaporation rate. At 1 800°C where 14 A/cm² is available the coating disappears at the rate of 1 mil thickness in about 300 hours. A.

537.583 : 621.385.2

7988. Determination of the saturation point of a diode on an experimental curve $\log J = f(\sqrt{F})$. H. Bonifas. *C.R. Acad. Sci., Paris*, **232**, 2082–4 (*June* 4, 1951) *In French.*

An expression for the effect of anode potential on the saturation emission is derived which is similar to that of Schottky but allows for the finite emission velocities. This shows that the $\log J \simeq \sqrt{F}$ characteristic exhibits a maximum (or a point of inflexion with a horizontal tangent) at the saturation point. Experimental results show that, for all types of cathode, the field required to give saturation is about 10^4 V/cm which leads to a radius of action for the surface atoms whose value is $\simeq 3\cdot8\times10^{-6}$ cm.

A. H. W. Beck

COSMIC RAYS 537.591

537.591.1

7989. Problems presented by cosmic radiation at the present time. J. Baltá Elias. *Bol. Radiactividad*, **23**, 3–85 (1950) *In Spanish.*

Fluctuations (periodical or accidental) noticed in the intensity of the cosmic radiation (considered many years ago as sensibly constant) are discussed, together with their possible causes. Further topics discussed are: the plurality of mesons; the problem of elementary particles; the origin of the cosmic radiation and its astrophysical and cosmological aspects. A.

537.591.1

7990. On the local gamma-radiation appearing in measurements of cosmic radiation at great depths. M. Miesowicz and J. M. Massalski. *Acta Phys. Polon.*, **10** (*No.* 3–4) 274–9 (1951).

New arguments showing that the low ionizing isotropic radiation giving more twofold than threefold coincidences in the measurements of cosmic rays at great depths is of local radioactive origin. A.

537.591.1

7991. High altitude measurements of the penetrating component intensity of cosmic radiation near the geomagnetic equator. A. S. Rao, V. K. Balasubrahmanyam, G. S. Gokhale and A. W. Pereira. Letter in *Phys. Rev.*, **83**, 173 (*July* 1, 1951).

The vertical intensity of radiation penetrating 10 cm Pb has been measured to balloon altitudes at Bangalore (3°N mag.), using counter telescopes of moderate aperture. The hard component rises to

maximum about ×4 sea level intensity at 120 mb and decreases at lower residual pressure. The disturbing effect of side showers is measured.

J. G. WILSON

537.591.1

7992. Cloud chamber observations of the neutral *V*-particle disintegration. R. W. THOMPSON, H. O. COHN AND R. S. FLUM. Letter in *Phys. Rev.*, **83**, 175 (*July* 1, 1951).

Nine V^0 disintegrations have been observed in a magnetic field of 3 100 gauss at sea level, the maximum detectable momentum of the apparatus being about 10 BeV/c. The counter system favours the selection of events originating in lead immediately above the chamber. Of the positive products of decay, two are identified as protons, while one is certainly not a proton. J. G. WILSON

537.591.1

7993. Average numbers for the development of the nucleon component of the cosmic radiation in air. H. MESSEL. *Proc. Phys. Soc., Lond. A*, **64**, 726–32 (*Aug.*, 1951).

Comprehensive results are presented in graphic form for nucleons with energies equal to or greater than 500 MeV, based on calculations using a new cross-section for nucleon-nucleon collisions and in the light of recent experimental evidence. The results obtained are in good agreement with existing experimental observations and it is felt that the high-energy nucleon component of the cosmic radiation can now be satisfactorily accounted for by the theory. The basic assumptions underlying the theory are discussed. A.

537.591.15

7994. The nature of the penetrating particles in extensive air showers. D. D. MILLAR. *Proc. Roy. Irish Acad.*, **54A** (*No.* 7) 115–23 (1951).

Experimental evidence is presented which shows that the results of Chowdhuri and of Janossy and McCusker [Abstr. 1980 (1949)] on the nature of the penetrating particles in air showers are incorrect, and that the absorbing properties of screening layers is not a function of position. Further experiments in which the distance of the remote shielding layer ("roof") is changed also give no indications of the presence of unstable particles of short path formed in this layer. J. G. WILSON

537.591.15

7995. On the penetrating showers of cosmic rays. A. G. VOISIN. *Canad. J. Phys.*, **29**, 205–16 (*May*, 1951).

Experiments have been carried out at sea level to measure penetration of particles from local showers produced in lead as a function of the angular width of the cone of shower particles. The shower particles are assumed to be mesons and are observed by counter arrangements connected in coincidence and anti-coincidence. The results show that the showers containing the more penetrating particles are those of wide angular spread. The multiplicity of penetrating particles per shower is estimated to be at least 3·7, and the curve of the angular distribution shows a maximum corresponding to a shower cone of a half angle of about 15°. A.

537.591.15

7996. Angular spreading of showers in heavy material. S. FRANCHETTI AND M. GIOVANNOZZI. *Nuovo Cim.*, **8**, 312–16 (*May*, 1951) *In Italian.*

Aims at extending the theory, account being especially taken of the different absorption in the material according to the angle made by the electrons with the shower axis. The calculations are based on the results of Roberg and Nordheim, and Richards and Nordheim. Curves are given for angular and energy distributions under lead. They show fair agreement with experimental (cloud chamber) results. A.

537.591.15

7997. The separation of components in extensive showers. G. CARMOUZE AND J. DAUDIN. *C.R. Acad. Sci., Paris*, **232**, 2018–20 (*May* 28, 1951) *In French.*

The proportion of Rossi showers under Pb at 2 860 m associated with extensive showers is shown to increase continuously as the area of the distant counter group (detecting the extensive shower) is increased. This result, together with the similarity of barometric coefficient of showers associated and not associated with extensive showers, suggests that none of these showers are in fact independent of larger showers. Similar experiments were carried out at 560 m and the results are compared. J. G. WILSON

537.591.15

7998. A new demonstration of the creation of nuclear showers by unstable particles. A. DAUDIN AND J. DAUDIN. *C.R. Acad. Sci., Paris*, **233**, 150–1 (*July* 9, 1951) *In French.*

Coincidences in heavily shielded counters at 2 860 m altitude are ascribed to nuclear effects. The barometer coefficient of the coincidence frequency found was −8·7% per cm Hg and the temp. coeff. −0·59% per °C. The temp. coeff. is discussed in terms of π-meson decay. E. P. GEORGE

537.591.15

7999. Relative arrival times of air shower particles. V. C. OFFICER. Letter in *Phys. Rev.*, **83**, 458 (*July* 15, 1951).

Three groups of Geiger counters, of which one could be covered with 10 cm Pb, were used to detect time lags of particles selected by penetration of this absorber. Results were negative, but the differences of shower density in shielded and unshielded trays lead directly to a spurious lag. J. G. WILSON

537.591.15

8000. Penetrating bursts of cosmic radiation. E. P. GEORGE AND P. T. TRENT. *Proc. Phys. Soc., Lond. A*, **64**, 733–45 (*Aug.*, 1951).

Bursts in an ion chamber, accompanied by the discharge of one or more of 18 surrounding Geiger counters separated from it by 15 cm Pb, have been studied at the Jungfraujoch, at sea level and below ground at a depth of 60 m water. With 15 cm Pb over the chamber the bursts at altitude were separated into those associated with air showers (accompanied bursts), and the remainder (local bursts). The accompanied penetrating bursts appear to be associated with the incidence of high-density regions of air showers. The local penetrating burst size increases

with the number of penetrating particles recorded consistent with their interpretation in terms of mixed showers involving the simultaneous production of charged and neutral mesons in energetic nuclear collisions of the N-component. Underground, about 10% of the bursts under 15 cm Pb are of the mixed shower type. These underground bursts are attributed to nuclear excitations produced by fast μ-mesons, resulting again in charged and neutral meson emission. About one-third of the bursts observed below ground with no Pb over the chamber appear to be produced by single penetrating particles which release, by an unidentified process, 20 MeV and more in the ion chamber. A.

537.591.2

8001. Energy distribution of the primary cosmic radiation. H. V. Neher. Letter in *Phys. Rev.*, **83**, 649 (*Aug.* 1, 1951).

Balloon flights with counter telescopes and ionization chambers measuring cosmic-ray flux and local ionization have been normalized at 310 g cm^{-2} depth by aeroplane flights between 0° and 64° geomagnetic, and lead to an empirical description of the primary cosmic-ray energy spectrum. This is indicated to be in substantial agreement with extensive shower, rocket and emulsion data. J. G. WILSON

537.591.2

8002. Zenith angle and momentum spectrum of μ-mesons at sea level. J. L. Zar. *Phys. Rev.*, **83**, 761–7 (*Aug.* 15, 1951).

The zenith-angle-dependence of the μ-meson intensity at sea level has been measured for several values of momentum between 280 and 1 080 MeV/c. Results were obtained by three methods: the coincidence, anticoincidence, and delayed coincidence methods, and it has been found that the shape of the zenith spectrum depended on which technique was used. The delayed coincidence method was capable of determining meson intensities in the presence of other types of penetrating particles. It suggests the existence of a considerable number of non-mesonic particles in the low energy region of the hard component. The lifetime of the meson was computed from its anomalous absorption in the atmosphere. It was found to be $2{\cdot}2 \pm 0{\cdot}3$ microseconds. A.

537.591.3

8003. The absorption of cosmic radiation at high altitudes. M. A. Pomerantz. Letter in *Phys. Rev.*, **83**, 459 (*July* 15, 1951).

The normalization of counter telescope data at high (balloon) altitudes for varying shielding layers is discussed. In 52°N latitude the absorption between 7·5 and 18·0 cm Pb is estimated to be 29%.

J. G. WILSON

537.591.5

8004. Meteorological effects on cosmic ray intensity and the meson spectrum. D. C. Rose. *Canad. J. Phys.*, **29**, 97–110 (*March*, 1951).

Continuous recording of the intensity of the hard component of cosmic rays has been carried out at Ottawa (Geomagnetic Lat. 56·8) and at Resolute (Geomagnetic Lat. 83) in the Canadian Arctic for over a year. Two counter telescopes with different amounts of lead shielding are used at each station. The results have been analysed for barometer effect in four series of observations each extending over three months. When averaged, they show a barometer coefficient of $-1{\cdot}75\%$ per cm Hg for mesons with momenta above 350 MeV/c and $-2{\cdot}13\%$ per cm Hg for those with momenta above 630 MeV/c. A calculation has been made of the temperature and barometer effects based on the variations in the probability of decay of mesons in the atmosphere, under varying atmospheric conditions. The calculations of the temperature effect do not yield results comparable with measurement; those of the barometer effect show that considerable information can be obtained about the meson spectrum from measurements of the barometer coefficients. The results favour a spectrum in agreement with parts of spectra measured by other authors. They suggest the possibility of a second maximum in the production spectrum of mesons. A

537.591.

8005. The sudden increase in cosmic ray intensity, November 19, 1949. D. C. Rose. *Canad. J. Phys.*, **29**, 227–35 (*May*, 1951).

Cosmic-ray counter telescopes were in continuous operation on November 19, 1949, at Ottawa (geomagnetic lat. 56·8°N) and at Resolute (geomagnetic lat. 83°N) in the Canadian Arctic. The two sets of apparatus were identical and consisted mainly of two counter telescopes, one with 6 in and the other with 14½ in of lead between counters. At Ottawa the counting rates of the individual counter trays were recorded as well as that of the coincidences. On November 19 at about 1048 GMT a sudden increase occurred at Ottawa. The maximum intensity reached about 70% above normal in a few minutes, then decayed slowly to normal in about four hours. The increase was similar in both counter telescopes and in the individual counter trays. At Resolute an increase was noted but of a different type. The intensity did not rise suddenly but increased slowly to about 20% above normal and returned to normal again in about three hours, centred about 1140 GMT. These results and those of other observers indicate that the beam of rays responsible for this increase must strike the earth on a limited area only. Some deductions can be made about the extent of this area.

537.591

8006. Sudden increase of cosmic ray intensity following large meteoric activity. H. F. Jongen. *Proc. K. Ned. Akad. Wet., Ser. B*, **54**, 253–5 (*May–June*, 1951).

On October 10th–11th, 1946, with an interval of nearly one day, an increase of cosmic-ray intensity was observed of 4%–6%, lasting several hours and apparently not correlated with a solar flare. It is suggested that the cause of this effect may be the passage of the earth in the early morning of October 10th, 1946, through meteoric debris belonging to the Giacobini–Zinner comet, meteoric activity during several hours having augmented by a factor 5 000.

537.59

8007. Observations of the latitude effect of penetrating showers. J. W. Sturgess. *Proc. Phys. Soc. Lond. A*, **64**, 745–51 (*Aug.*, 1951).

The latitude effect of the local penetrating shower

of cosmic radiation produced in paraffin has been measured at sea level and found to be in the ratio of $1{\cdot}8 \pm 0{\cdot}4$ between London and Dakar, French West Africa. The extensive penetrating showers showed no latitude effect, which is consistent with the greater energy of these showers. The background frequency of local showers, i.e. those recorded with no absorber above the counter system, was found to be insensitive to latitude and reasons for this are discussed. A.

537.591.5

8008. On the diurnal variation of extensive air showers of high density at 3 500 m above sea level. C. Ballario, B. Brunelli, A. De Marco and G. Martelli. Letter in *Phys. Rev.*, **83,** 666 (*Aug* 1, 1951).

An extended system of counter trays was used in coincidence with further trays of low efficiency to select showers of high density. A diurnal effect of $2{\cdot}24 \pm 0{\cdot}70$ was observed, and discussed in terms of an even greater diurnal effect of primaries with energy $> 10^{16}$ eV. E. P. GEORGE

537.591.8

8009. Cosmic-ray events in very thick photographic emulsions. P. Demers. *Ann. Acfas*, **16,** 74–6 (1950) *In French.*

Layers of unbacked emulsion 150 μ thick have been built up in a stack 4·5 mm thick. Out of 12 stars 2 double stars have been observed. Many of the stars observed are complete in the emulsion.

E. P. GEORGE

537.591.8

8010. Isolated tracks produced in nuclear emulsions by cosmic rays. H. Moucharrafieh and S. Rebaud. *J. Phys. Radium*, **12,** 527–34 (*April*, 1951) *In French.*

The reduction of measurements of directions and of directional intensities in nuclear emulsions is discussed. Ilford ($C3 + B$) plates were exposed at 4 500 m in 3°S lat. The zenith-angle intensity variation of upward and downward moving particles which stopped in the emulsion, and of all particles not stopping, were determined, and the energy spectrum of singly charged particles heavier than mesons.

J. G. WILSON

537.591.8

8011. Remarks on the production of cosmic-ray mesons. Y. Yamaguchi. Letter in *Progr. Theor. Phys.*, **6,** 260–1 (*March–April*, 1951).

537.591.8

8012. Neutron production by cosmic-ray particles at sea level and underground. R. D. Sard, M. F. Crouch, D. R. Jones, A. M. Conforto and B. F. Stearns. *Nuovo Cim.*, **8,** 326–40 (*May*, 1951) *In Italian.*

Further measurements are reported of disintegration neutrons produced in Pb by charged cosmic-ray particles that stop in the Pb [$(AB - C : N)$ events] or that penetrate the Pb [$(ABC : N)$ events]. To distinguish between mechanisms, the same apparatus was used at two different sites, one near sea level and the other in the sub-basement of a skyscraper, at an equivalent depth below sea level of 1 200 g cm^{-2} air. At this depth the star-producing radiation should be attenuated at least 60-fold, the penetrating shower producing radiation at least 9-fold. Both the $(AB - C : N)$ and the $(ABC : N)$ rates, are, however, only reduced by a factor of about 6. It is concluded that with the 158 g cm^{-2} Pb filter in place above the telescope all of the underground $(AB - C : N)$ rate and about half of the sea level $(AB - C : N)$ rate is due to the capture of negative μ-mesons that stop in the Pb absorber below the telescope. The average neutron multiplicity per stopped negative meson is about 2. The persistence of the $(ABC : N)$ rate underground suggests neutron production by fast μ-mesons, though the depth of the site is not sufficient to make this conclusion certain. Comparison with W. B. Fowler's counter data shows that practically none of the sea-level $(ABC : N)$ rate can be ascribed to fast μ-mesons; underground, the mesonic contribution is appreciable. At both sites, removal of the Pb filter from above the telescope increases the $(AB - C : N)$ rate; it is probable that part of this soft neutron-producing radiation consists of electron-photon showers secondary to the fast mesons. A.

537.591.8

8013. Evidence of multiple meson production. J. B. Swan. Letter in *Nature, Lond.*, **168,** 73 (*July* 14, 1951).

The counting rate of a 3-fold telescope containing 10 cm Pb and inclined at 60° to the vertical was found to be independent of azimuth. E. P. GEORGE

537.591.8

8014. Transition effect in Pb of the star-producing radiation in the stratosphere. I. M. M. Shapiro, B. Stiller, M. Birnbaum and F. W. O'Dell. Letter in *Phys. Rev.*, **83,** 455 (*July* 15, 1951).

The transition effect in Pb is examined using plates located in a vertical slot cavity in a Pb block, a single plate carrying exposures at a succession of depths. Results, briefly compared with mountain data, show (i) a star intensity greater than the free space value on top of the block, (ii) maxima for all sizes of stars at ~ 27 g cm^{-2} and ~ 60–70 g cm^{-2}, the latter representing the transition build-up of star-producing secondaries. J. G. WILSON

537.591.8

8015. Transition effect in Pb of the star-producing radiation in the stratosphere. II. M. M. Shapiro. Letter in *Phys. Rev.*, **83,** 456 (*July* 15, 1951).

The effect on the transition curves (preceding Abstr.) of the wide zenith angle distribution in the stratosphere as compared with mountain altitudes is examined. The nature of the curves is also considered to be incompatible with the assumption that the effects of neutrons as secondaries are over-riding.

J. G. WILSON

537.591.8

8016. The attenuation of nucleon cascades in lead. W. G. V. Rosser and M. W. Swift. *Phil Mag.*, **42,** 856–67 (*Aug.*, 1951).

The frequency variation of nuclear interactions under Pb has been studied by comparing the rates of stars in Ilford G5 emulsions exposed above and below 30 cm Pb. The size frequency distribution is the same for stars in both sets of plates. Attenuation lengths in Pb are given. The ratio of the attenuation length to

the interaction mean free path for penetrating showers is (1·8 ± 0·3). The percentage of all stars produced by charged relativistic primaries increases from (13·1 ± 0·9)% for the unshielded plates to (17·0 ± 1·0)% for the plates under Pb due to the formation of stars by π-mesons generated in Pb. The ratio of charged to uncharged penetrating-shower primaries increases from (0·86 ± 0·21) for the air plates to (1·94 ± 0·32) for the plates exposed under 30 cm Pb. It is suggested tentatively that the increase is due to the production of penetrating showers by fast π-mesons created in the Pb. A.

MAGNETISM 538

538.082

8017. The form of pole pieces for the measurement of magnetic susceptibilities. A. Pacault, J. Hoarau and J. Joussot-Dubien. *C.R. Acad. Sci., Paris*, **232**, 1932–4 (*May* 21, 1951) *In French.*

Pole pieces are described which are suitable for accurate measurement of magnetic susceptibilities by the Faraday method using very small quantities.

W. R. ANGUS

538.082.74 : 621.317.422

8018. A new method for the quick estimation of coercive force. J. Brož and F. Vilím. *Čas. Pěst. Mat. Fis.*, **75** (*No.* 3) D307–D312 (1950) *In Czech.*

An attempt to solve the problem of quick determination of the coercive force for current samples of ferromagnetic materials. The method makes use of the uncompleted circuit of the investigated sample and the determination of the coercive force is performed by means of an a.c. magnetized circuit. By measuring the leakage flux produced by the sample and passing through the magnetic circuit the coercive force is determined. It is possible to determine the coercive force for samples of different cross-sections.

A.

538.114

8019. The dependence of the ferromagnetic Curie point on the magnetic field. K. M. Koch. *Öst. Ingen.-Arch.*, **5** (*No.* 3) 278–84 (1951) *In German.*

It is proved that the description of ferromagnetism by means of the theory of ordered states according to Bragg and Williams (in analogy to the case of superconductors) leads to a dependence of the Curie point on the magnetic field. The resistance and the differential thermoelectric force have been measured on the same material (Ni) for dependence on the temperature and in cases of field intensities up to 9 000 oersted. If one tries to extrapolate a Curie point from the curves obtained, a dislocation from about 10 degrees for $H = 9\,000$ oersted takes place in both cases. A.

538.114

8020. On the inertia of oscillating ferromagnetic domain walls. G. T. Rado. *Phys. Rev.*, **83**, 821–6 (*Aug.* 15, 1951).

It is shown that the inertia of an oscillating ferromagnetic domain wall can be calculated without making any assumptions with regard to the damping mechanism. Physical considerations other than damping are used to formulate appropriate approximations. The particular distribution of spin orientations in an oscillating wall is discussed, and the possibility of dynamic interactions between domain rotations and the wall displacement is pointed out. The inertia of a wall in periodic motion is found to agree with that obtained by Döring for the special case of uniform motion. It is concluded that the inertia depends solely on characteristics of the wall at rest, provided the distortion of the moving wall is sufficiently small to ensure the linearity of the equation of motion. A.

538.22

8021. Investigation of the magnetic characteristics of ordered alloys of the system Co–Mn. F. Galperin. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 6) 1011–13 (1951) *In Russian.*

538.22

8022. Magnetic study of the copper and nickel salts of normal dibasic acids. J. Ploquin and C. Vergneau. *C.R. Acad. Sci., Paris*, **232**, 2439–40 (*June* 25, 1951) *In French.*

A magnetic study of the Cu and Ni salts of the normal aliphatic dibasic acids from oxalic to sebacic indicates partial magnetic dissimulation of Cu. Formation of a complex between the Cu and the two carboxyl groups of the acid is believed to occur.

W. R. ANGUS

538.22

8023. Magnetochemistry of the copper salts of certain organic dibasic acids. C. Vergneau. *C.R. Acad. Sci., Paris*, **233**, 164–5 (*July* 9, 1951) *In French.*

A magnetic study of the Cu salts of organic dibasic acids where complex-formation between the Cu and the carboxyl groups is inhibited by introduction of a halogen atom, branching, or other modification in the polymethylene chain verifies the theory previously proposed (preceding Abstr.) that partial magnetic dissimulation of the Cu is caused by complex formation. W. R. ANGUS

538.22

8024. Magnetic study of some organo-metallic compounds of arsenic. M. Prasad and L. N. Mulay. *J. Chem. Phys.*, **19**, 1051–6 (*Aug.*, 1951).

The susceptibility of As has been evaluated from the molecular susceptibilities of organo-metallic compounds of the type (i) $R.AsH_2$, R_3As, (ii) R–As : As–R, (iii) $RAs : O(OH)_2$, $R_2As : O(OH)$ and $R_3As(OH)_2$, using Pascal's constants for atoms and linkages in the organic radicals R and those derived for : O and —OH groups in arsenic acids. The values obtained from (i) and (ii) are in agreement with Honda's value for arsenic element. These values and that deduced from (iii), are much different from Salter's theoretical value for As atom. In the (i) arsines, (ii) arseno-compounds and (iii) arsenic acids, a distinct linear relationship has been observed between the molecular susceptibility and the total number of electrons in the molecule. The linear relation has been used to evaluate the susceptibility of the As atom in these compounds, which is in agreement with Slater's theoretical value.

538.22 : 539.213.2

8025. Antiferromagnetism and structure of Cr_2O_3. G. FOËX AND J. WUCHER. *C R. Acad. Sci., Paris*, **232**, 2193–4 (*June* 11, 1951) *In French.*

Whereas crystalline specimens of Cr_2O_3 exhibit antiferromagnetism below 330°K and Weiss paramagnetism ($p_B = 3 \cdot 85\ \mu_B$) above, amorphous specimens are not antiferromagnetic and the p_B value is much smaller than for the crystalline oxide. A tentative interpretation of this decrease, based on a partial unquenching of the orbital moment, is given.

E. P. WOHLFARTH

538.221

8026. Microwave resonance absorption in ferromagnetic semi-conductor. I. Nickel ferrite. T. OKAMURA, Y. TORIZUKA AND Y. KOJIMA. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 663–72 (*Aug.*, 1950).

The microwave resonance absorption in $NiOFe_2O_3$ was observed in the range of 7·5 cm and 3·2 cm, and the magnetic saturation value of $NiOFe_2O_3$ was determined by means of the method of Ismuth's rotating pole. From these measurements, g-values were calculated by Kittel's formula and found to be $g = 2 \cdot 26 \pm 0 \cdot 02$ at 3·2 cm and $g = 2 \cdot 03 \pm 0 \cdot 10$ at 7 cm respectively; thus it was ascertained experimentally that as the wavelength becomes shorter, the g-value becomes greater, even supposing the probable error in the experiment. A.

538.221

8027. Microwave resonance absorption in semiconductor. II. Magnetite single crystal. T. OKAMURA AND Y. TORIZUKA. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 822–7 (*Oct.*, 1950).

The microwave resonance absorption in magnetite single crystal was observed at various orientations of the crystal by using (110) and (100) plane specimens at the wavelength of 3·2 cm and 6·5 cm. The absorption amount and applied magnetic field corresponding to the maximum of absorption were obtained as a function of crystal orientation. Furthermore, from the results of experiment, g-factor and anisotropy energy K_1 were calculated by Kittel's formula at both wavelengths. At shorter wavelength, the experimental result shows a satisfactory agreement with Kittel's theory, but at longer wavelength fairly large discrepancy between experiment and theory was found. Thus Kittel's formula seems not to hold at such frequencies, a resonance occurring at lower field in which the magnetization is not saturated. A.

538.221

8028. On the ferromagnetic resonance absorption in magnetite single crystals at 9 400 Mc and 4 560 Mc. T. HIRONE, H. WATANABE, J. MIZUNO AND N. TSUYA. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 774–9 (*Oct.*, 1950).

The ferromagnetic resonance absorption phenomena in single crystals of magnetite were studied at 9 400 and 4 560 Mc/s to investigate the relation between the absorption phenomena and the magnetization processes of a specimen. The data obtained at both frequencies were reproduced theoretically on the basis of a mechanism similar to that proposed by Kip and Arnold, using common g-factor ($g = 2 \cdot 08$) and magnetic anisotropy constant K ($K = -1 \cdot 49 \times 10^5$ erg cm^{-3}). The range of distribution of spontaneous magnetization due to the stress energy existing in this ferromagnetic substance was taken into consideration. The absorption curve in [100] direction at the higher frequency had an additional hump on the lower side of the resonance field and these facts were explained taking into account the rotation mechanism of spontaneous magnetization. A.

538.221

8029. Ferromagnetism and antiferromagnetism. *Paris, Centre National de la Recherche Scientifique* (1951) 360 *pp.*

A collection of papers presented at an international colloquium. For abstracts see Abstr. 6312–15, 6317, 6322–5, 6328–43, 6348–51, 6368, 7063–9, 7074–8, 7081, 7102–3, 7105, 7140–2 (1951).

538.221

8030. On the ferromagnetism of the β_1 phase of Co-Zn alloys. A. J. P. MEYER AND P. TAGLANG. *C.R. Acad. Sci., Paris*, **232**, 1914–16 (*May* 21, 1951) *In French.*

Magnetic measurements on Co–Zn alloys indicate that the β_1 phase exists between 48 and 55 at. % Zn. In this region the mean magnetic moment is approximately constant. A. E. DE BARR

538.221

8031. Structure and properties of ferrites. F. G. BROCKMAN. *Elect. Engng, N.Y.*, **70**, 489–94 (*June*, 1951).

A review of the crystal structure of ferrites and of Neel's analysis of the experimental results on their magnetic properties. Much of the behaviour of these materials may be explained on the assumption that the magnetic ions are distributed on two lattices and that the interactions between these ions are negative. A brief account is given of a recent analysis of superexchange forces. A. E. DE BARR

538.221 : 537.311.33 : 541.127

8032. On the reaction kinetics of spinel-type ferrite. I. Nickel ferrite. T. OKAMURA AND J. SIMOIZAKA. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 673–894 (*Aug.*, 1950).

The reaction kinetics were investigated by measuring the magnetic intensity which exhibits itself at various reaction temperatures, keeping other conditions constant, and the value of the experimental activation energies for formation of the spinel-type ferromagnetic oxide was obtained from the temperature dependence upon a magnetic intensity representing the velocity of the progress in the reaction; thus, the value of activation energy was found to be 44 000 cal/mol and 25 000 cal/mol for the dry and wet methods respectively. These values were compared respectively with those for the ordinary solid reaction and for lattice defect in ionic crystal. The electrical conductivity of Ni ferrite under various heat treatments was also measured and it was found that $NiOFe_2O_3$ shows quite large electric resistivity, after heating at 1 100°c for 3 hours in air. Lastly, the relation between electrical conductivity and magnetic property was

discussed on the basis of the theory of ferromagnetism for semiconductors. A.

538.221 : 538.24

8033. A new magnetic transition of Mn-ferrite. T. Okamura and J. Simoizaka. Letter in *Phys. Rev.*, **83**, 644 (*Aug.* 1, 1951).

Experiments at different temperatures (−200°c to 50°c) and at various field strengths (0 to 8 oersted) show that Mn ferrites, in common with other inverse spinel structures, undergo a transition in the temperature range −150°c to 20°c. In this range the magnetization decreases with decreasing temperature, the decrease being a function of the field strength. For fields $> 6{\cdot}1$ oersted the magnetization increases on lowering the temperature. E. P. WOHLFARTH

538.221 : 538.652

8034. On the dynamical characteristics of the magnetostriction alloy "Alfer." H. Masumoto and G. Ôtomo. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 413–19 (*June*, 1950).

The dynamical characteristics of the Fe–Al magnetostriction alloys containing from $6{\cdot}36$ to $14{\cdot}38\%$ Al has been measured by the bridge method in fields of 5, 10, 15 and 20 oersteds. It has been found that two curves representing the relations of the magnetostrictive activity and the sound velocity in a field of 10 oersteds to the concentration have respectively maximum and minimum portions in the range of $\sim 12{\cdot}2$ to $13{\cdot}4\%$ Al contents; this range almost coincides with that of the maximum portion ($11{\cdot}5 \sim 13{\cdot}2\%$ Al) in the case of static magnetostriction. The largest value of magnetostrictive activity is $0{\cdot}058$ of $13{\cdot}19\%$ Al alloy and the sound velocities in the minimum portion range from 4 500 to 4 540 m/sec. A small addition of Ni to these alloys substantially increases their magnetostrictive activities. The electroacoustic energy conversion efficiencies of these alloys are of the same order as that of Ni: these alloys may be used in its place as a magnetostriction vibrator. A.

538.222

8035. Magnetism of hydrogen and lithium ions. W. R. Myers. Letter in *Nature, Lond.*, **167**, 1073–4 (*June* 30, 1951).

By an analysis of experimental results (molar susceptibility of H and Li halides) it is concluded that H^+ and Li^+ ions in solution are effectively paramagnetic. E. P. WOHLFARTH

538.222

8036. Paramagnetic resonance in vanadous ammonium sulphate. B. Bleaney, D. J. E. Ingram and H. E. D. Scovil. *Proc. Phys. Soc., Lond. A*, **64**, 601–8 (*July*, 1951).

In the solid state the orbital momentum of the divalent V ion $3d^3$ is quenched by the cubic crystalline field, leaving a spin quadruplet as the ground state. Paramagnetic resonance measurements show that in $V(NH_4)_2(SO_4)_2 \cdot 6H_2O$ this is split into two doublets with a separation of $0{\cdot}36\ cm^{-1}$ by a component of the crystalline field with rhombic symmetry. An extensive and isotropic hyperfine structure is observed, from which the value of 7/2 for the nuclear spin of V^{51} is confirmed. The contribution from the observed splittings to the tail of the magnetic specific heat curve is evaluated. A.

538.222

8037. Paramagnetic resonance and hyperfine structure in four cobalt salts. B. Bleaney and D. J. E. Ingram. *Proc. Roy. Soc. A*, **208**, 143–58 (*Aug.* 22, 1951).

The paramagnetic resonance spectra of Co ammonium sulphate, Co potassium sulphate, Co fluosilicate and Co sulphate, each diluted with the isomorphous Zn salt, have been analysed. These salts exhibit great anisotropy both in the g-values (spectroscopic splitting factor) and the hyperfine structure. The results show that the ground state of the Co ion is an electronic doublet, and confirm the nuclear spin of Co^{59} as $\frac{7}{2}$. The theoretical interpretation of the results by crystalline field theory has been carried out by Abragam and Pryce [Abstr. 5577 (1951)]. The contribution to the specific heat from the hyperfine structure is computed for each salt. In addition, the measurements of the specific heat and susceptibility of Co sulphate by Fritz and Giauque are given a new interpretation consistent with that of other cobalt salts. This requires that the magnetic entropy of cobalt sulphate be taken as $R \log_e 2$, instead of $R \log_e 4$, as assumed by Fritz and Giauque. A.

538.222 : 530.162 : 539.13

8038. Statistics of a linear paramagnetic macromolecule. W. Opechowski and J. M. Bryan. *Canad. J. Phys.*, **29**, 236–44 (*May*, 1951).

The partition function of a linear "macromolecule" composed of N paramagnetic atoms subject to the Ising interaction is calculated for an arbitrary N. From the partition function the expressions for the specific heat and the initial paramagnetic susceptibility are obtained. It is shown on the example of the susceptibility that the procedure, customary in statistical mechanics, which consists in using the asymptotic expressions ($N \to \infty$) to describe actual physical systems (N very large, but finite) should be used with some caution in the region of very low temperatures. A.

538.222 : 548.0

8039. Paramagnetic resonance absorption crystals containing color centers. M. Tinkham and A. F. Kip. Letter in *Phys. Rev.*, **83**, 657 (*Aug.* 1, 1951).

The general findings of Hutchison [Abstr. 7384 (1949)] are confirmed with F-centres at low concentrations in KBr, but the resonance curve is symmetrical. D. H. WHIFFEN

538.224

8040. The influence of Brillouin zones on the physico-chemical properties of alloys. H. Witte, H. Klee and K. H. Lieser. Letter in *Naturwissenschaften*, **38** (*No.* 8) 185–6 (1951) *In German.*

The state-diagram for $MgCu_2$–$MgZn_2$ splits into 3 phases in all of which the magnetic susceptibility becomes diamagnetic on filling the zones. J. JACOBS

538.23

8041. Magnetic viscosity of Permalloy in aperiodically varying and in sinusoidal fields. R. V. Telesnin and S. Z. Ushakov. *J. Tech. Phys., USSR*, **20** 1366–71 (*Nov.*, 1950) *In Russian.*

The magnetic viscosity on the back of the hysteresis

loop was determined in partial cycles, the peaks of which have the back of the maximum loop as envelope. The partial cycles were obtained by a Helmholtz pendulum contact-breaker. The magnitude of the magnetic viscosity is determined by a definite state of the ferromagnetic, i.e. that value of the magnetic field at which the process of the magnetization ends. In investigating the viscosity by partial cycles in an aperiodically varying field the viscosity manifests itself much less frequently than in a process following the maximum loop, although the final state of the ferromagnetic may be the same. The viscosity on the peak of a partial cycle is much higher than in the central part of the cycle. The permeability was also measured on the same partial cycles at acoustic frequencies. After eliminating the influence of eddy currents a considerable "viscous fall" of the permeability occurred at increasing frequencies. B. F. KRAUS

538.24

8042. Torque curves and other magnetic properties of Alcomax. K. HOSELITZ AND M. MCCAIG. *Proc. Phys. Soc., Lond. B*, **64**, 549–59 (*July*, 1951).

Using a torque magnetometer, the crystal anisotropy constants of the permanent alloy Alcomax III have been determined. The type of magnetocrystalline energy after rapid cooling is cubic with a positive constant (iron-like); after slow cooling cubic with a negative constant (nickel-like); and after cooling in a magnetic field uniaxial with a positive constant (cobalt-like). The changes in crystal anisotropy are compared with parallel measurements on the hysteresis curve. A direct experiment shows that when the field applied during cooling makes an angle with the crystal axes, the preferred direction is much nearer to a [100] axis than the field direction. A.

538.24

8043. Domain patterns on nickel. H. J. WILLIAMS AND J. G. WALKER. *Phys. Rev.*, **83**, 634–6 (*Aug.* 1, 1951).

Domain patterns have been observed on 2 single crystals of Ni cut in the form of hollow parallelograms. The length of the sides were parallel to the ⟨111⟩ directions in one specimen and to the ⟨110⟩ directions in the other. The crystals show domain structures with the 3 types of domain boundaries which are to be expected from a material having the directions of easy magnetization along the ⟨111⟩ directions. Domain boundary movement under the influence of an applied magnetic field was observed. A.

538.24 : 548.0

8044. Some new Bitter patterns on a single crystal of nickel. L. F. BATES AND G. W. WILSON. *Proc. Phys. Soc., Lond. A*, **64**, 691–5 (*Aug.*, 1951).

Some new Bitter figures have been obtained on a single crystal of Ni whose surface is a (111) plane when magnetized along a [110] direction, and a curve obtained of domain boundary spacing as a function of the effective magnetic field. Patterns of a complex nature, probably due to closure domains, were also obtained on a (112) plane. A.

538.245 : 538.114

8045. A note on the theory of the coercive force. H. WATANABE. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 429–36 (*June*, 1950).

The origin of the coercive force is considered on the basis of the experiment by Williams and Shockley [Abstr. 2616 (1949)]. It is concluded that the shape of the domain boundary is not a plane, and the coercive force is determined by the sum of the gradients of the boundary energy associated with those cavities, which are sited on the concave portion of the boundary surface facing towards the direction of advance. A.

538.245 : 538.114

8046. On the large Barkhausen jump and the internal stress in Perminvar wire. T. HIRONE, S. OGAWA AND T. HUZIMURA. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 491–7 (*June*, 1950).

The changes, in a ferromagnetic substance, of (1) the reversible permeability at the remanence point; (2) the residual magnetization; and (3) the energy of magnetization from the remanence point to magnetic saturation, due to the action of external tension, were discussed taking into account the internal stress existing in the substance. These quantities were measured on the Perminvar wire under the action of external tension and the results were compared with the theoretical one. The strength of internal stress existing in the Perminvar wire was estimated. A.

538.245 : 538.114

8047. On the discontinuous displacement of magnetic domain boundary of the ferromagnetic substance due to tension. T. HIRONE AND S. OGAWA. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 498–502 (*June*, 1950).

It was found experimentally that a discontinuous expansion of a magnetic reversal nucleus occurs in a uniformly magnetized ferromagnetic substance (Perminvar wire) due to varying external tension. This phenomenon is caused by a change of surface energy of the nucleus boundary due to varying tension. On the basis of this idea, the critical strength of tension for the discontinuous displacement of the nucleus boundary was calculated. The results obtained agreed well with the measured value of critical tension. From these results it is to be concluded that 180° magnetic domain boundary is displaced discontinuously by the action of varying external tension. A.

538.245 : 538.652

8048. Magnetic structure of highly-coercive alloys. IV. Hysteresis of magnetostriction in the highly coercive alloys Alnico and Vikalloy. D. A. SHTURKIN AND YA. S. SHUR. *J. Tech. Phys., USSR*, **20**, 1393–9 (*Nov.*, 1950) *In Russian.*

For Pt III, see Abstr. 1876 (1950). Experimental investigation of the hysteresis of magnetostriction on Alnico and Vikalloy specimens which had been given various magnetic structures by special treatments. The results are analysed under the assumption of the existence of a special magnetic structure in these alloys characterized by the fact that the ferromagnetic consists of finely dispersed flakes magnetically isolated from each other by non-ferromagnetic interstices, each flake representing a single domain of spontaneous magnetization. Owing to this the processes of technical magnetization are only due to a rotation of the magnetization vectors of the individual domains. The orientation of the magnetization within a single domain is determined by the shape of the flakes, which have very anisotropic

demagnetization factors, and also by the interaction of the magnetization vectors of the individual domains. Also, the thermo-magnetic treatment of the Alnico and tempering after strong cold-working of the Vikalloy result in the magnetic flakes growing in an orientated fashion, this accounting for the strong anisotropy of the magnetic properties. B. F. KRAUS

538.26 : 537.534 : 621.384.61 : 621.318.23

8049. Design of a cyclotron magnet. I. Pole design using a half-magnet. M. Foss, J. G. Fox, R. B. Sutton and E. C. Creutz. *Rev. Sci. Instrum.*, **22**, 469–72 (*July*, 1951).

In order to measure the effects of gross changes in the design of the pole and yoke for a large synchrocyclotron cheaply and conveniently, a model half-magnet having a 2 in diameter pole was constructed. From data on the fields produced by poles of various lengths using a fixed amount of copper in the coil, the pole length for which the cost of power and magnet steel was a minimum could be determined. Measurements of the efficiencies of poles of various shapes indicated that it would be possible to design a shimmed pole to have an efficiency of 70 to 75% at a field of 20 000 gauss. Finally, data on overall magnet efficiency as a function of the ratio of the cross-sectional areas of the yoke and pole permitted calculation of the ratio for which the cost of steel, copper and power would be a minimum. A.

ELECTROMAGNETISM : ELECTRODYNAMICS 538.3/.5

538.3

8050. Reflections on the Ehrenhaft magneto-photophoresis. F. C. Roesler. *Acta Phys. Austriaca*, **4** (*No.* 4) 445–56 (1951) *In German.*

Schedling has suggested [Abstr. 510 (1951)] that some of the observed facts of magneto-photophoresis can be accounted for on the hypothesis of a force between the gas molecules and the suspended particle. Helical orbits are possible in these circumstances, and if the particle has a dipole moment, these orbits can be made stable by applying an external magnetic field. Unless there is some mutual reaction between the particle and the gas molecules, no energy can be transferred to the particle. N. CORCORAN

538.3

8051. Use of potentials and antipotentials in the canonical scheme of the theory of the electromagnetic field. B. Kwal. Letter in *J. Phys. Radium*, **12**, 571–2 (*April*, 1951) *In French.*

It is suggested that one should introduce in electromagnetic theory, besides the ordinary 4-vector (e.m. potential), a completely antisymmetric tensor of the third order (antipotential). A generalized Lagrangian then gives both groups of Maxwell's equations at the same time. L. PINCHERLE

538.3

8052. General expression of the electromagnetic field of a helix. E. Roubine. *C.R. Acad. Sci., Paris*, **232**, 2297–8 (*June* 18, 1951) *In French.*

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

8053. On oscillations in electron streams. R. Q. Twiss. *Proc. Phys. Soc., Lond. B*, **64**, 654–65 (*Aug.* 1951).

A critical discussion is given of the conventional procedure for determining whether a particular electron stream is unstable. It is shown that in some cases where this analysis suggests instability the stream is stable, while in others, where instability does occur, neither the frequency nor the rate of build-up of oscillations are as predicted. The physical causes of instability in an electron stream are also considered. A

538.561 : 537.52

8054. Plasma oscillations. D. Gabor. *Brit. J. Appl. Phys.*, **2**, 209–18 (*Aug.*, 1951).

A comprehensive review is given of the state of knowledge on plasma oscillations in the narrower sense, and of those electronic oscillations which are determined by the internal dynamics of the discharge rather than by the outer circuit. Experimental and theoretical work is reviewed and a new mathematical formulation is given for oscillations in "irrotational" streams. If the electrons and ions originate outside a magnetic field, or if they issue from cathodes where the magnetic field has no normal component, the curl of the total or Schwarzschild momentum will be zero everywhere. In this important case the self-consistent equations of any number of electron or ion streams can be completely formulated in a series of differential equations for certain vector stream functions; one function for each stream. Comparatively few cases have been discussed so far with the proper boundary conditions. The most important targets for research are pointed out. A

538.565 : 621.396.611.

8055. On a resonator for metre and decimetre waves. M. Magat and M. Bruma. *C.R. Acad. Sci., Paris*, **232**, 2413–15 (*June* 25, 1951) *In French.*

The instability of a klystron type resonator was overcome by introducing a variable cylindrical capacity in parallel with the plane capacity localized between the bases of the two cylinders. L. PINCHERL

538.565 : 621.396.611.

8056. On the theory of electromagnetic waves in resonant cavities. H. B. G. Casimir. *Philips Res. Rep.*, **6**, 162–82 (*June*, 1951).

The theory of standing electromagnetic waves in resonant cavities is surveyed. The formal analogy between the modes of vibration of a cavity, the modes of vibration of a network of discrete elements, and the vibration of a simple LC-circuit is emphasized. Special attention is given to the theory of perturbations, and this theory is then applied to a number of examples, including the determination of the h. properties of magnetic materials by means of cavities into which small spheres of the material are introduced, and the coupling of two identical cavities by a small hole in a dividing wall. The zero-point energy of empty space is considered. A

538.565 : 621.396.611.4 : 621.392.52

8057. Microwave filters employing a single cavity excited in more than one mode. W.-G. LIN. *J. Appl. Phys.*, **22**, 989–1001 (*Aug.*, 1951).

A cavity resonator with input and output couplings represents a two-terminal-pair network with an infinite number of natural modes of oscillation. In some cavities of special shape, a number of degenerate modes with identical natural frequencies can be found. In a single cavity, various numbers of these degenerate modes can be coupled together to form a chain of coupled circuits by perturbing the otherwise ideal geometrical configuration of the cavity. The filter behaviour is prescribed, and the two-terminal-pair network realizing this is obtained by a process of synthesis. A.

538.566 : 621.396.671.4

8058. The impedance of an antenna over a large circular screen. J. E. STORER. *J. Appl. Phys.*, **22**, 1058–66 (*Aug.*, 1951).

In aerial measurements the aerial is usually placed over a large conducting screen, and the assumption made that the measurements are in close agreement with those that would be obtained if the screen were of infinite size. Recent experimental work, however, indicates that the finiteness of the ground screen may influence the measurements to a considerable extent. This paper treats the problem of an aerial erected vertically in the centre of a circular screen. An integral equation is obtained for the electric field in the plane of the screen, outside the screen. This equation is solved approximately by the use of a variational principle, and a formula is obtained for the change of aerial impedance as a function of the diameter of the screen. The formula may be used to give a simple and accurate estimate of the changes introduced by the use of a finite screen. A.

538.566.2 : 537.521

Measurement of the electron density in ionized gases by microwave techniques. *See Abstr.* 7912–13

538.566.2

8059. E.m. radiation of large wavelength in a strongly ionized medium. B. KWAL. *C.R. Acad. Sci., Paris*, **232**, 2009–11 (*May* 28, 1951) *In French.*

Quantum formulae are not applicable because they are derived under the hypothesis of the emission of only one quantum. The classical theory can be applied, however, for temperatures $\sim 10^6$ °, except when the impact parameter is much larger than the Debye length. L. PINCHERLE

538.566.2

8060. Wave packets, the Poynting vector, and energy flow. II. Group propagation through dissipative isotropic media. C. O. HINES. *J. Geophys. Res.*, **56**, 197–206 (*June*, 1951).

For Pt I, see Abstr. 6366 (1951). Before a treatment of dissipative media can be carried out, it is necessary to find expressions for the velocity of a wave packet in such media. In the present paper, an intermediate step of some general applicability is taken—that of finding the group speed in a dissipative isotropic medium. It is found that the most appropriate expression for this is $c/(dkn_1/dk)$, where n_1 is the real part of the refractive index at frequency $kc/2\pi$. In the course of the development, a common laxity in the formulation of the group is corrected, and also expressions are obtained which are applicable to the transmission of pulses through slabs of material. A.

538.566.2

8061. Wave packets, the Poynting vector, and energy flow. III. Packet propagation through dissipative anisotropic media. C. O. HINES. *J. Geophys. Res.*, **56**, 207–20 (*June*, 1951).

Formulae are developed giving the velocity of packet propagation in dissipative anisotropic media, for both homogeneous and inhomogeneous waves. A.

538.566.2 : 534.213

8062. Derivation of the dispersion equation for Alfvén's magneto-hydrodynamic waves from Bailey's electromagneto-ionic theory. J. W. DUNGEY. Letter in *Nature, Lond.*, **167**, 1029–30 (*June* 23, 1951).

Bailey's general theory of plane waves in an ionized gas [Abstr. 5590 (1949)] is shown to cover the case of Alfvén's transverse waves [Abstr. 2309 (1951)]. Åström and Herlofson's results for plasma oscillations [Abstr. 8016–17 (1950)] are also compared with deductions from Bailey's theory.

R. A. NEWING

538.566.2 : 621.396.11

8063. On the partial reflection of electromagnetic waves in the troposphere. H. ISRAËL AND K. SOMMERMEYER. *Z. Met.*, **3**, 32–9 (*Jan.–Feb.*, 1949).

A marked partial reflection of electromagnetic waves by atmospheric formations can only occur if the dielectric constant at the reflecting surface changes considerably in a distance shorter than or at the most of the same order as the wavelength. Most reflections at inversions, etc., are limited to waves of a few 100 m or more. Dm-waves can be reflected by water vapour discontinuities in transient turbulent eddies, mostly over the sea, and in thunderclouds and the space above them. Uniform ionization density in a thundercloud cannot explain reflection, and authors suggest local ionization in discharge channels.

METEOROLOGICAL ABSTRACTS

538.566.2 : 621.396.11

8064. Contribution to abnormal refraction of ultra-short-waves in the atmosphere. W. DATTAN. *Z. Met.*, **3**, 50–5 (*Jan.–Feb.*, 1949).

The 7·9 m wave was received at a distance of 180 km, due to reflection from a relatively low layer in the atmosphere. METEOROLOGICAL ABSTRACTS

538.566.2 : 621.396.11

8065. On the variation of the velocity of propagation of radio waves. A. STOYKO. *C.R. Acad. Sci., Paris*, **232**, 1916–18 (*May* 21, 1951) *In French.*

Measurements between America and Europe have confirmed that the "direct" apparent velocity is around 272 000 km/sec. Seasonal variations were also investigated. L. PINCHERLE

538.566.2 : 621.396.11

8066. Relation between terrestrial magnetism and the propagation of radiowaves between Washington and Bagneux. P. LEJAY, J.-M. ARDILLON AND G. BERTAUX. *C.R. Acad. Sci., Paris*, **232**, 1975–6 (*May* 28, 1951) *In French.*

A close correlation is found between magnetic

conditions and the quality of reception at Bagneux of waves in the decametre-band from WWX. Reception is weak for several days following magnetic disturbance. A. T. PRICE

538.566.3 : 551.510.535

8067. The mechanism of *F*-layer propagated back-scatter echoes. A. M. PETERSON. *J. Geophys. Res.*, **56**, 221–37 (*June*, 1951).

An analysis of the mechanism of *F*-layer propagated (2*F*) back-scatter is given, together with the results of multifrequency experimental observations. It is shown that when scattering is assumed to occur at the surface of the earth, rather than in the *E*-region, theory agrees very well with the experimental evidence. The behaviour of back-scatter for transmission near the critical frequency confirms the ground-origin hypothesis and is particularly difficult to explain in terms of *E*-region origin. It is shown that the leading edge of the echo corresponds to energy returned from scattering centres beyond the edge of the skip-zone. Energy from the skip-zone edge is returned with greater delay, the time-differential becoming larger as the *F*-layer vertical-incidence critical frequency is approached. Great care is clearly needed if meaningful skip-distance information is to be obtained from back-scatter observations. The rapid build-up in echo amplitude which follows a sharply defined minimum time-delay is explained in terms of a time-delay focusing phenomenon. A.

538.566.3 : 621.396.11

8068. Measurements of the direction of arrival of short radio waves reflected at the ionosphere. E. N. BRAMLEY AND W. ROSS. *Proc. Roy. Soc. A*, **204**, 251–67 (*June* 22, 1951).

Using a phase-comparison method [Abstr. 7135 (1951)], measurements have been made of the direction of arrival of waves reflected at the ionosphere during normal daytime conditions, both over an oblique path corresponding to a range of 700 km and at nearly vertical incidence. The frequency range covered was 4 to 15 Mc/s, and using pulsed signals the direction of arrival of discrete rays could be studied. The work so far carried out has been confined principally to 1st-order *F*-layer reflections. The results show that a typical 1st-order *F*-echo exhibits both rapid (sec to sec) fluctuations in direction and slow changes of a quasi-period of many minutes (ranging from a few up to more than 30 min). These results confirm earlier deductions from direction-finding studies and are interpreted as indicating that large-scale and apparently random tilts occur in the ionosphere. The results are consistent with others obtained in Australia by different methods which suggest that there are compressional waves in the atmosphere at the height of the *F*-layer, and that these waves have a wavelength of several hundred km and a velocity of some 5 to 10 km/min. A.

538.567.4 : 621.396.619

8069. The distribution of energy in randomly modulated waves. D. MIDDLETON. *Phil. Mag.*, **42**, 689–707 (*July*, 1951).

The distribution of energy in h.f. oscillations which are modulated by stationary, random disturbances such as shot and thermal noise is here examined in a number of important practical situations. The theory for frequency- and phase-modulation by normal random noise is developed in particular, as a model for speech-modulated carriers. The effect of spectral shape of the modulating noise on the intensity distribution of the modulated carrier is considered, and it is found that the lowest-frequency components of the modulation are most significant in this respect. For example, in f.m. the carrier term is entirely absent when the modulating noise has a finite spectral density at and near zero-frequency, while in p.m. by the same disturbance the carrier component may contain a noticeable fraction of the modulated wave's energy. Particular attention is also given to the limiting cases of very slow frequency deviation, and it is found that such adiabatic sweeps spread the original spectrum. A parallel discussion follows for the amplitude-modulation by normal random noise, including the effects of possible over-modulation. A.

538.569

8070. Energy density of monochromatic radiation in a dispersive medium. H. PELZER. *Proc. Roy. Soc. A*, **208** (*No.* 1094) 365–6 (1951).

The mean value of the energy density of a transverse wave in a dispersive medium is shown to be larger than that of $(ED + HB)/8\pi$ by a factor which is in agreement with an expression derived by Huang [Abstr. 8346 (1951)]. A.

538.569 : 530.145 : 548.7

On the interaction between the radiation field and ionic crystals. *See Abstr.* 8346

538.569 : 535.343.4–14

8071. The absorption of microwaves in excited hydrogen. G. E. REESOR. *Canad. J. Phys.*, **29**, 87–96 (*March*, 1951).

Direct absorption measurements were made upon excited atomic H in a discharge tube placed inside a waveguide. Two ranges of wavelengths in the 3 cm region were investigated. The results can be satisfactorily explained by absorption due to free electrons. Although the $2s^2S_{\frac{1}{2}}$ to $2p^2P_{\frac{3}{2}}$ transition of atomic hydrogen is in this region, no selective absorption was observed. A.

MAGNETIC EFFECTS 538.6

538.614

8072. Magnetic rotatory power of carbon bisulphide at low temperature. R. DE MALLEMANN, F. SUHNEL AND A. MALEVERGNE. *C.R. Acad. Sci., Paris*, **232**, 1982–3 (*May* 28, 1951) *In French.*

The rotation A, density *d*, and refractive index *n* have been measured for CS_2 from $+20°$ to $-80°$. In this interval the A variation exceeds 8%, while the rotativity is constant near 52×10^{-5}. J. JACOBS

538.614

8073. Magnetic rotatory powers of methane and ethylene. R. DE MALLEMANN AND F. SUHNER. *C.R. Acad. Sci., Paris*, **232**, 2067–8 (*June* 4, 1951) *In French.*

Pure specimens were available. For C_2H_4 precis

measurements were made up to below normal pressure. The specific rotation is invariant from $0 \rightarrow 4$ atm. J. JACOBS

538.614

8074. Magnetic rotatory powers of neon and of nitrous oxide. R. DE MALLEMANN AND F. SUHNER. *C.R. Acad. Sci., Paris,* **233,** 122–4 (*July* 9, 1951) *In French.*

The magnetic rotatory powers of Ne gas and of gaseous and liquid N_2O have been examined.

W. R. ANGUS

538.614 : 536.48

8075. Thermal variation of the Faraday effect in liquid oxygen. F. GAUME. *C.R. Acad. Sci., Paris,* **232,** 2304–5 (*June* 18, 1951) *In French.*

From measurements at 12 temperatures between 63·4°K and 94·6°K the Verdet constant, specific magnetic rotatory power, and rotativity of liquid O are found to decrease steadily with temperature.

W. R. ANGUS

538.63

8076. The change of the electric resistance of bismuth crystals in strong magnetic fields. IV. The discussion and interpretation of the experimental results. Y. TANABE. *Sci. Rep. Res. Inst. Tôhoku Univ. A,* **2,** 531–48 (*June,* 1950).

For Pt III, see Abstr. 5620 (1951). Gives a theoretical discussion of the experimental results. The large resistance changes and pronounced anisotropy characteristics are interpreted satisfactorily on the basis of Jones theory. The dependence on the relative orientation of field, current and crystal axes is not so far explicable.

E. P. WOHLFARTH

538.63 : 538.66 : 536.7

Thermodynamics of thermomagnetic and galvanomagnetic effects. *See Abstr.* 7828

538.632

8077. A new method for precision measurement of the Hall and magneto-resistive coefficients. J. J. DONOGHUE AND W. P. EATHERLY. *Rev. Sci. Instrum.,* **22,** 513–16 (*July,* 1951).

A circuit capable of measuring alternating current potentials up to 1 000 μV with a precision of 0·01 μV has been devised and applied to the measurement of the galvanomagnetic coefficients of semi-conductors and metals. The circuit consists essentially of a peaked amplifier applied to the out-of-balance signal between an alternating current potentiometer and the potential being measured. The galvanomagnetic coefficients are so related to the potentials that the entire measurement becomes independent of the current. As an example of the results obtainable, data are given to show the variations of the Hall and magneto-resistivity coefficients during the high-temperature graphitization of index rod. The precision of the final data is of the order of $\frac{1}{4}$%. A.

538.639

8078. Anomaly of the even thermomagnetic effect of alloys of the system Ni–Mn. R. G. ANNAEV. *J. Tech. Phys., USSR,* **20,** 1360–5 (*Nov.,* 1950) *In Russian.*

Anomalies of the even thermomagnetic effect in the alloys of the Ni–Mn system were discovered for the first time. This anomaly may be interpreted by the theory of Akulov and Vonsovskiĭ [Akulov, *Ferromagnetism,* Moscow 1939; Vonsovskiĭ, Abstr. 2035 (1949)]. A method of investigating the even and odd thermomagnetic effects for various temperatures of the junctions is presented for specimens of small linear dimensions (up to 40 mm). B. F. KRAUS

538.652

8079. Change of sign of the magnetostriction coefficient due to tension. II. A. ELSAS AND E. VOGT. *Z. Naturforsch.,* **6a,** 233–8 (*May,* 1951) *In German.*

For Pt I, see Abstr. 2606 (1950). Measurements of magnetostriction of a Heusler alloy, Fe–Ni alloys and Ni are reported. Experiments are carried out which enable $(\partial I/\partial\sigma)_H$ and $(\partial\lambda/\partial H)_\sigma$ to be compared, σ being the applied tension. The ratio of the two quotients is > 1 for the Heusler alloy and < 1 for Ni. Deductions are made as to the contributions to the magnetization process due to reversible and irreversible boundary movements. For the Fe–Ni alloys λ becomes $-$ve for high σ, although the constituent crystals have $+$ve, though highly anisotropic, values of λ_{100}, λ_{110}, λ_{111}. This anisotropy, together with a theoretical formula due to Becker and Döring, is invoked to interpret the change of sign of λ.

E. P. WOHLFARTH

538.653

8080. The initial susceptibility of nickel under tension. H. J. PEPPIATT AND B. N. BROCKHOUSE. Letter in *J. Appl. Phys.,* **22,** 985–6 (*July,* 1951).

The initial susceptibility χ of a pure Ni wire has been measured under different tensional stresses Z both in the annealed state and after code working. Between -40°C and 100°C χZ varies linearly with temperature, the variation being greater for the specimen after cold working than in the annealed state. A. E. DE BARR

538.653.16

8081. Domain wall relaxation in nickel. W. P. MASON. Letter in *Phys. Rev.,* **83,** 683 (*Aug.* 1, 1951).

Gives a brief theoretical treatment of the frequency dependence of the ΔE effect. Experiments show that ΔE decreases with increasing frequency, while the decrement δ increases at first and reaches a maximum at about 150 kc/s. These effects are shown quantitatively to be due to a relaxation in domain wall movement, owing to induced eddy currents. E. P. WOHLFARTH

538.69

8082. Magnetic properties of acids and bases. (Preliminary communication.) F. EHRENHAFT AND F. STOCKINGER. *Acta Phys. Austriaca,* **4** (*No.* 4) 489–96 (1951) *In German.*

If a soln. of an acid and a soln. of a base are placed in a magnetic field, separated only by a semipermeable membrane, a clockwise rotation is set up in the soln. of the base, when viewed in the direction of the field. For a 6N soln. of KOH in a field of $\sim 60\,000$ maxwell, rotation takes place at approx. 30 r.p.m. After 5 to 20 min (depending on the conc. and

substances used) the direction of rotation is reversed. Other more complicated motions are observed, and work is proceeding on a theory. N. CORCORAN

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11 : 537.311.33

8083. Theory of the temperature effect of electronic energy bands in crystals. II. T. MUTO AND S. OYAMA. *Progr. Theor. Phys.*, **6**, 61–4 (*Jan.–Feb.*, 1951).

The authors' theory of the temperature-dependence of the energy gap of non-polar semiconductors [Abstr. 5626 (1951)] is applied to Si, Ge and diamond. It is pointed out that some of the numerical data required for comparison with experiment (sound velocities, mobilities and effective masses) are rather uncertain. P. T. LANDSBERG

539.11/.32

8084. Overlap forces and elastic constants of body-centered cubic metals. I. ISENBERG. *Phys. Rev.*, **83**, 637–40 (*Aug.* 1, 1951).

It is shown that the interactions between neighbouring ions which one must postulate for the ordering of β-phase alloys are very similar to the interactions which one must postulate so that these alloys are stable under a (110) [1$\bar{1}$0] shear. One can then understand why in all known cases the β-phase either disappears at low temperatures or becomes ordered. The elastic constants of W are also examined; the contribution of ion-ion overlap to these constants is obtained by subtracting estimated values of the other contributions from the experimental values. It is relatively easy to understand the values of the ion-ion overlap contributions if one assumes an antiferromagnetic array in W as proposed by Zener. These values are difficult to understand if one assumes a random spin orientation. A.

MOLECULAR STRUCTURE 539.13

539.13

8085. Anomalies in the microwave spectra of symmetric molecules. H. H. NIELSEN. *Physica*, **17**, 432–9 (*March–April*, 1951).

For axially symmetric molecules of species C_{3v} the 2nd-order term in the expansion of H is $H_2 = H_2' + H_2''$ where H_2'' does not normally contribute to H_2, it contains corrections in rotational motion due to non-rigidity and a centrifugal stretching term. These terms assume significance for 2-fold degenerate oscillations $\perp^r$ to the symmetry axis. J. JACOBS

539.13

8086. On the choice of constants in the definition of free valence on the basis of Penney bond orders. O. CHALVET AND M. ROUX. *C.R. Acad. Sci., Paris*, **232**, 2320–1 (*June* 18, 1951) *In French.*

The relation between molecular orbital free valence F and the coeff. K of the π-electron contribution to the activation energy is compared with the relation of free valence J based on Penney definitions and self-polarizability. On a certain choice of constants F and J are connected showing the functional relation between K and J. J. JACOBS

539.132

8087. Solution of Thomas–Fermi equation for molecules with axial symmetry. J. ŁOPUSZAŃSKI. *Acta Phys. Polon.*, **10** (*No.* 3–4) 213–22 (1951).

Gives analytic solutions of the Thomas–Fermi equation for neutral molecules with axial symmetry at distances very large or very small compared with the intervals between the nuclei. In the intermediate region these solutions can be combined using an interpolation with polynomials. Such an interpolation admits a determination of constants in the far solution from the boundary conditions. The solution at large distances from the nuclei is a superposition of the solution for spherical symmetry and a corrective term in the form of a development into Legendre spherical functions. Calculations have been carried out for the case of molecules consisting of two identical atoms. A.

539.132

8088. Electronic states of C_2-molecule. I. Interaction between *p*-electrons. G. ARAKI, S. TUTIHASI AND W. WATARI. *Progr. Theor. Phys.*, **6**, 135–53 (*March–April*, 1951).

Electron states of a C_2-molecule are discussed by the method of atomic orbitals without taking into account an effect of inner shells of the component C-atoms. Adiabatic potentials are numerically computed for all states which arise from configurations consisting of two atoms with two p-electrons each. Binding energies and equilibrium distances for attractive states are evaluated from these potentials. It is found that $(2p\sigma^2, 2p\sigma^2)^1\Sigma_g^+$ and $(2p\sigma^2, 2p\sigma\ 2p\pi)^3\Pi_u$ are the deepest and first excited state respectively, and that $(2p\sigma\ 2p\pi, 2p\sigma\ 2p\pi)^1\Delta_g$ is a highly excited state in contradiction to the Pauling theory. However, the present study is the first step and the result is not conclusive for the C_2-molecule. The effect of 2s-shells on the order of the states will be considered in Pt II. A.

539.132

8089. Two-centre integrals with 2*s*- and 2*p*-functions. II. H.-J. KOPINECK. *Z. Naturforsch.*, **6a**, 177–83 (*April*, 1951) *In German.*

Completes an earlier discussion [Abstr. 1218 (1951)] by the calculation of the remaining "ion-integrals," the results being presented both analytically and numerically. R. H. DALITZ

539.132

8090. The force fields of carbon and silicon tetrafluorides. J. W. LINNETT AND D. F. HEATH. Letter in *J. Chem. Phys.*, **19**, 801–2 (*June*, 1951).

Repulsion terms introduced to account for the observed vibration frequencies of CF_4 and SiF_4 agree well with those expected from the known interactions of inert-gas atoms. Calculated frequencies based on

the orbital valency force field [Abstr. 3367, 4911, 4912 (1949)] are tabulated and compared with the observed values. W. R. ANGUS

539.132

8091. The pure quadrupole spectrum of solid chlorine. R. LIVINGSTON. Letter in *J. Chem. Phys.*, **19**, 803 (*June*, 1951).

From the pure quadrupole spectrum of solid Cl_2 at liquid N temperature, it appears that the bond in the molecule uses essentially a *p* orbital with very little *s* hybridization. W. R. ANGUS

539.132

8092. Intermolecular forces in methyl chloride. V. MYERS AND R. PETERS. Letter in *J. Chem. Phys.*, **19**, 804–5 (*June*, 1951).

Optical dispersion data, dipole moment and second virial coefficients are used to calculate semi-empirically the forces between CH_3Cl molecules. W. R. ANGUS

539.132

8093. On the electronic levels of polyacenes. R. LEFEBVRE. *C.R. Acad. Sci., Paris*, **232**, 2223–5 (*June* 11, 1951) *In French.*

Platt's free electron model is imitated for the molecular orbital method by combining the orbitals so as to form bases for irreducible representations of D_{2h}. The sequence of energy levels obtained agrees with that of Coulson. J. JACOBS

539.132

8094. On the analytical expression for quantities in the theoretical chemistry of two chains derived from polyenes. R. GOUARNÉ. *C.R. Acad. Sci., Paris*, **232**, 2321–3 (*June* 18, 1951) *In French.*

An evaluation of the relevant molecular orbital coeffs. J. JACOBS

539.132

8095. Concerning cyclic polyenes. J. F. TINKER. Letter in *J. Chem. Phys.*, **19**, 981–2 (*July*, 1951).

For predictions of resonance stabilization the number of conjugated double bonds alone is insufficient and steric effects must also be considered. J. JACOBS

539.132

8096. Transition-probabilities for diatomic symmetrical molecules (vibrational spectra). R. BOUIGUE. *C.R. Acad. Sci., Paris*, **232**, 2401–3 (*June* 25, 1951) *In French.*

A simplified modification of Morse's wave-equation allows a calculation of the vibrational transition-probabilities for a symmetrical diatomic molecule. D. R. BARBER

539.132

8097. Kinetic energy matrix for linear molecules. S. M. FERIGLE AND A. G. MEISTER. Letter in *J. Chem. Phys.*, **19**, 982–3 (*July*, 1951).

An extension of the definition of Wilson's *s* vectors to include the case of 3 or more collinear nuclei. J. JACOBS

539.132

8098. The variation of atomic polarizabilities in molecular vibrations. F. MATOSSI. *J. Chem. Phys.*, **19**, 1007–10 (*Aug.*, 1951).

The depolarization factor of Raman lines of totally symmetric vibrations can be calculated in agreement with the general concepts of the polarizability theory of the Raman effect and with the concept of mutual interaction of dipoles if it is assumed that the polarizability of an atom depends on the interatomic distances in a molecule. When the totally symmetric species contains more than one vibration, the vibrational patterns, and thus the force constants, are among the factors that determine the depolarization. The results of the theory are evaluated for linear diatomic and triatomic molecules. The utilization of the method for checking force constants and molecular structures is pointed out. A.

539.132

8099. Force constants, frequency assignments, and thermodynamic properties of ozone. M. J. KLEIN, F. F. CLEVELAND AND A. G. MEISTER. Letter in *J. Chem. Phys.*, **22**, 1068–9 (*Aug.*, 1951).

539.132

8100. Dependence of magnetic shielding of nuclei upon molecular orientation. N. F. RAMSEY. *Phys. Rev.*, **83**, 540–1 (*Aug.* 1, 1951).

An expression is calculated for the dependence of the magnetic shielding of nuclei in linear molecules upon the magnetic quantum number of the molecule. The expression for the dependence upon orientation is shown to consist of two different terms. The first of these is directly related to the spin-rotational magnetic interaction constant of the molecule. Since the interaction is known experimentally in the important case of molecular H, this term can directly be evaluated from the experimental measurements. The other term is proportional to $(3\zeta^2 - r^2)/r^3$ averaged over the electron co-ordinates in the molecule. This term can be calculated from the wave function of the H molecule. For molecular H, the dependence of the nuclear shielding upon the molecular orientation is in principle measurable. Such a measurement, combined with the theory of the paper, provides an important check on the molecular H wave function. A.

539.132

8101. Centrifugal distortion in asymmetric molecules. II. HDS. R. E. HILLGER AND M. W. P. STRANDBERG. *Phys. Rev.*, **83**, 575–81 (*Aug.* 1, 1951).

For Pt I, see Abstr. 7154 (1951). A perturbation method for relating the theory of centrifugal distortion in asymmetric top molecules to observed microwave Q branch, *a* or *c* type transitions, is presented. The formula for the distortion correction is expressed in terms of the total angular momentum, *J*, the symmetry axis momentum of the nearest symmetric top, *K*, and 5 distortion constants. The formula yields a satisfactory fit to the observed spectrum of HDS ($\kappa \simeq -0{\cdot}5$). The electric dipole moment is determined as $1{\cdot}02 \pm 0{\cdot}02$ debye. The inertia defect and distortion constants are calculated. The effective structure for the HDS molecule so determined is in agreement with infrared determinations. A.

539.132

8102. A note concerning *l*-type doubling in axially symmetric molecules, in particular with reference to molecules belonging to the symmetry groups C_{4v} and V_d. J. DE HEER. *Phys. Rev.*, **83**, 741–5 (*Aug.* 15, 1951).

It is shown that *l*-type doubling may be expected

in both degenerate Coriolis levels (referring to a positive and a negative product of the quantum numbers K and l, respectively). A detailed analysis of a pyramidal XY_4 model reveals that the doubling in these two levels is of the same order. On the basis of the discussion a microwave absorption pattern is predicted for the transitions $J = 1 \rightarrow J = 2$, $\Delta K = 0$, where a molecule of C_{4v} or V_d symmetry is in an excited degenerate vibration state. An interesting example may be provided by IF_5 if this molecule has the C_{4v} structure recently proposed. A.

539.132 : 535.338

8103. Characterization of electronic transitions in complex molecules. M. KASHA. *Disc. Faraday Soc., No.* 9, 14–19 (1950).

A summary is given of the types of conclusions which may be drawn from a study of the emission properties of complex molecules under optical excitation in suitable systems. The types of radiationless transitions in complex molecules are discussed, and a resultant spectroscopic criterion stated: The emitting level of a given multiplicity is the lowest excited level of that multiplicity. Intercombinations in complex molecules are described, and their importance is shown to arise from the high probability of the excitation of triplet states—a conclusion which runs counter to the trend of spectroscopic thought of a few years ago. An atomic number criterion is stated (after McClure) which permits the identification of intercombinations by a study of intensity of the transition with heavy atom substitutions in a complex molecule. Finally, a listing of empirical criteria is made which permits a distinction between pure π-electron transitions ($\pi \rightarrow \pi^*$) and transitions involving excitation of non-bonding N, O, and S atom electrons to anti-bonding π molecular orbitals ($n \rightarrow \pi^*$). The most definitive of these criteria is the disappearance of $n \rightarrow \pi^*$ transitions in acid media. An unusual enhancement of the spin-orbit coupling process for $\pi \rightarrow \pi^*$ transitions is reported and a possible interpretation is given. A.

539.132 : 535.343

8104. The low excited states of simple aromatic hydrocarbons. D. P. CRAIG. *Disc. Faraday Soc., No.* 9, 5–14 (1940).

Discusses the present position as regards spectral assignment in the aromatic series. In the simplest cases of benzene and cyclobutadiene the effect of configuration interaction is greatly to diminish the importance of polar structures from the large value associated with conventional MO wave functions. This brings the state wave functions, as well as the sequence of their energies, much nearer to those of VB theory. The general support given to the VB theory by its agreement in simple cases with a non-empirical theory allows some confidence in its use for more complex molecules. In 'acenes, polar structures being excluded, low-lying A_g and B_{3u} states ought to be calculable without serious error. Low-lying B_{1g} and B_{2u} states will only be so calculable when polar structures are included. The assignments in 'acene spectra which these considerations support are set out and discussed. A.

539.132 : 535.343.4–14 : 539.

8105. Radiofrequency spectra of H_2 and D_2 b new molecular beam resonance method. N. F. RAMS *Physica*, **17**, 388–91 (*March–April*, 1951).

Preliminary experiments with the new method v separated high frequency fields [Abstr. 7409 (19 show that narrow resonance curves and high accur are obtainable. D. H. WHIF

539.132 : 535.37

Raman spectrum of tetramethyldiborane. *See Ab* 7771

539.132 : 535.375.5 : 535.343.3/.4

Force constants for 1,1,1-trichloroethane. *Abstr.* 7735

539.

8106. On the electronic exchange effects in calculation of dipole moments. Degree of ionizat and dipole moments of halogen hydrides. D. KASTL *C.R. Acad. Sci., Paris*, **232**, 2323–6 (*June* 18, 1951) *French.*

Complete antisymmetrization of the wave functic leads to reasonable degree of ionization as deduc from dipole moments assuming pure p-bonds. J. JAC

539.

8107. The effect of configurational interaction on dipole moment and on transition moments. Exam of the C═N group. C. SANDORFY. *C.R. Acad. S Paris*, **232**, 2449–52 (*June* 25, 1951) *In French.*

Configurational interaction lowers both dip moment of the ground state and N–V intensity, givi better agreement with experimental values. J. JAC

539.

8108. Binding energy and dipole moment of alk halide molecules. E. S. RITTNER. *J. Chem. Phys.*, 1030–5 (*Aug.*, 1951).

A simple theory of alkali halide gas molecules the spirit of Born–Mayer lattice theory is presente The molecule is considered to be constituted of io each of which is polarized by the electrostatic field the other. This deformation polarization has t important consequences: (1) the net dipole mome of the molecule becomes appreciably lower than th given by the product of the electric charge e, and t internuclear separation a; (2) the repulsion consta (determined from empirical data) become differe from the corresponding constants for the cryst The theory yields satisfactory results for the bindi energy, vibration frequency, and dipole moment, in all instances where necessary data are availab In cases where the internuclear distances are n known experimentally, they are calculated from t theory using experimental binding energies. It possible to assign to the ions Goldschmidt-like rad the sums of which reproduce reasonably well bo the calculated and the observed internuclear distance Finally, item (1) above explains why Pauling criterion for the fraction of ionic character, $f = \mu/e$ is not a very good measure of ionicity for the completely ionic substances.

539.133

8109. Nuclear proton resonance in related liquid hydrocarbons. R. Bradford, C. Clay, A. Craft, E. Strick and J. Underhill. Letter in *Phys. Rev.*, **83**, 656 (*Aug.* 1, 1951).

Line-width parameters of four long-chain hydrocarbons vary from 10^{-4} sec ($\Delta H = 0{\cdot}37$) for octadecane to 8×10^{-4} sec ($\Delta H = 0{\cdot}05$) for dodecane.

539.133 : 535.375.5

8110. The Raman spectrum of fluorine. D. Andrychuk. *Canad. J. Phys.*, **29**, 151–8 (*March*, 1951).

The rotational and vibrational Raman spectra of gaseous F_2 at 1 atm. pressure were obtained. From these spectra the constants of the molecule in the electronic ground state were determined to be: $B_0 = 0{\cdot}8828\ cm^{-1}$, $r_0 = 1{\cdot}417_7 \pm 0{\cdot}001$ Å, $\Delta G_{\frac{1}{2}} = 891{\cdot}8_5 \pm 0{\cdot}4\ cm^{-1}$. The intensity alternation in the rotational spectrum shows that the nuclear spin of F_2 is $\frac{1}{2}\ h/2\pi$ and that the F^{19} nuclei follow Fermi statistics. A.

539.133 : 541.57 : 535.341–15

Measurements of the stretching vibrations of OCS and CS_2. *See Abstr.* 7694

ATOMIC STRUCTURE . NUCLEUS. ISOTOPES 539.15

539.15

8111. Fundamentals of atomic physics. H. A. Bauer. *Vienna, Springer-Verlag* (1951) 631 *pp.*

This fully revised edition, containing 327 more pages than the third, embodies three new chapters upon Schrödinger's perturbation theory, the relativistic generalization of wave mechanics (Dirac's theory) and quantum statistics. New experimental developments in atomic physics are given special emphasis, nuclear reactors and particle accelerators being dealt with comprehensively. Numerical results quoted have been checked and all physical constants have been corrected where necessary to correspond with currently accepted values.

539.152

8112. The spectrum of positronium. V. B. Berestetskiĭ. *Guide Russ. Sci. Period. Lit., Brookhaven*, **4**, 40–7 (*Feb.*, 1951).

Full English translation of the article abstracted as Abstr. 3320 (1950).

539.152

8113. The existence of Wheeler-compounds. A. Ore. Letter in *Phys. Rev.*, **83**, 665 (*Aug.* 1, 1951).

The stability of the "compound" H^-e^+ is established by using a variational method to obtain a lower limit of 0·07 eV on the binding energy.

W. J. SWIATECKI

539.152.1

8114. On the Gamow convolutions of the low-energy regions. O. Monecke. *Experientia*, **7** (*No.* 7) 255–7 (1951).

The problem is treated with the aid of the isotope system developed by the author. Six exactly delimited convolutions result, upon which a fine structure is superimposed (convolutions of the second order). [See Abstr. 2619, 4259 (1950)]. A.

539.152.1

8115. On the excited states of even nuclei. H. Horie, M. Umezawa, Y. Yamaguchi and S. Yoshida. Letter in *Progr. Theor. Phys.*, **6**, 254–6 (*March–April*, 1951).

The spins of certain even nuclei suggest that two nucleons couple to produce spin 2 and 4 in the first and second excited states (in contrast with spin 0 of the ground state). W. J. SWIATECKI

539.152.1

8116. Note on nuclear radii. D. Curie. Letter in *J. Phys. Radium*, **12**, 570–1 (*April*, 1951) *In French.*

Nuclear radii have been calculated from total cross-sections for very fast (42 MeV) neutrons using the Feshbach and Weisskopf equation $\sigma = 2\pi(R + \lambda)^2$ and experimental data obtained at Berkeley on 33 elements ranging from H to U. The author deduces that the increase of radius with atomic number depends upon the nuclear shell that is being filled and suggests the use of an expression $R^3 - r^3 = K(A - a)$ where r, a and K are constants characteristic of the shell which is being filled. L. R. SHEPHERD

539.152.1

8117. Energy levels of a spheroidal nuclear well. S. Granger and R. D. Spence. Letter in *Phys. Rev.*, **83**, 460 (*July* 15, 1951).

The energy levels of a nucleon in an infinitely deep spheroidal well are calculated as function of its eccentricity ε. Results are plotted for $n = 1$, 2 and for quantum numbers (l, m) of the undistorted nucleus up to 3. For $\varepsilon < 0{\cdot}1$, levels agree with the perturbation calculations of Feenberg and Hammack [Abstr. 4599 (1951)]. R. H. DALITZ

539.152.1

8118. Radii of even-even nuclei with alpha-fine structure. M. A. Preston. Letter in *Phys. Rev.*, **83**, 475 (*July* 15, 1951).

The radius of a decaying excited state is calculated for three even-even α-emitters from the decay constant, using the one-particle square well model with the angular momentum appropriate to the α-particle emitted, and is compared with the radius of the ground state in each case. R. H. DALITZ

539.152.1

8119. Nuclear shell structure and nuclear density. L. M. Yang. *Proc. Phys. Soc., Lond. A*, **64**, 632–8 (*July*, 1951).

Correlations between the nuclear shell structure and the density distribution are analysed on the assumption that the former is associated with the successive appearance of particles of higher angular momentum. General requirements for the possible form of the nuclear density distribution are derived. It is shown that a reasonable density distribution conforming with the above requirements and other known facts reproduces unmistakably the "magic numbers." A.

539.152.1 : 535.343.4–14

8120. Determination of nuclear properties by microwave spectroscopy. C. H. TOWNES. *Physica*, **17**, 354–77 (*March–April*, 1951).

A review of microwave spectroscopy in gases with special reference to the measurements of nuclear masses, spins, magnetic and quadrupole moments.

D. H. WHIFFEN

539.152.1 : 537.533.74

8121. The influence of the size of the nucleus on the retardation radiation. G. S. SAAKYAN. *J. Exp. Theor. Phys., USSR*, **20**, 787–94 (*Sept.*, 1950) *In Russian.*

The differential cross-section for the scattering of electrons with energies $E_0 \geqslant (125/A^{1/3})$ MeV (A is the mass number of the nucleus) for large angles with due regard to the size of the nucleus, decreases when compared with the corresponding differential cross-section for nuclei the size of which is not considered. In the limiting case of $E_0 \gg (125/A^{1/3})$ MeV, the decrease is Z-fold. Therefore, investigations of the scattering of electrons at large angles ($\theta \simeq \pi/2$) may serve as a means of determining the nuclear radius and the distribution of charge in them. In this work the retarding radiation at large angles is investigated and two formulae are obtained containing the dimensions of the nucleus.

BROOKHAVEN GUIDE TO RUSSIAN LITERATURE

539.152.2

8122. The magnetic moment of the atomic nucleus. S. VELAYOS. *Bol. Radiactividad*, **23**, 153–69 (1950) *In Spanish.*

The methods employed for the determination of atomic nucleus are described, beginning with the description of the phenomenon of nuclear resonance which constitutes the basis of nearly all the methods mentioned. The determination of the magnetic moment of the neutron is also described. A.

539.152.2

8123. Study of a transient phenomenon in nuclear resonance. M. SOUTIF AND R. GABILLARD. *Physica*, **17**, 319–27 (*March-April*, 1951) *In French.*

The polarizing field is of the form $H_0 + H_m \sin 2\pi ft$ ($f = 50$). H_m is switched on suddenly and the signal appearing every $\frac{1}{50}$ sec decays exponentially with a time constant T to a steady value. If H_1 is the amplitude of the h.f. field, $T = T_1 + \text{const.}\ H_1^2$. An elementary derivation of this formula is also given. L. PINCHERLE

539.152.2

8124. The double T bridge in nuclear magnetic resonance. P. GRIVET, M. SOUTIF AND R. GABILLARD. *Physica*, **17**, 420–6 (*March–April*, 1951) *In French.*

A study of its balancing, sensitivity and noise.

L. PINCHERLE

539.152.2

8125. On the possibility of studying long-duration nuclear magnetizations and their relaxation with simple methods. A. KASTLER. Letter in *J. Phys. Radium*, **12**, 567–9 (*April*, 1951) *In French.*

539.152.2

8126. Influence of the phase memory of a spin system on the form of the nuclear resonance signals. R. GABILLARD. *C.R. Acad. Sci., Paris*, **233**, 39–4 (*July* 2, 1951) *In French.*

539.152.

8127. Calculation of nuclear magnetic moments M. MIZUSHIMA AND M. UMEZAWA. Letter in *Phys Rev.*, **83**, 463 (*July* 15, 1951).

Using the j–j coupling scheme magnetic moment of nuclei with a closed shell ± 1 or ± 3 nucleons ar calculated and found to agree well with experiment.

W. J. SWIATECK

539.152.

8128. On the ratio of the nuclear magnetic an electric quadrupole interactions for atomic Cl^{35} an Cl^{37}. V. JACCARINO AND J. G. KING. Letter in *Phys Rev.*, **83**, 471 (*July* 15, 1951).

The h.f.s. of the $^2P_{3/2}$ state of Cl^{35} and Cl^{37} was re examined by the atomic beam radiofrequenc magnetic resonance method. Results for both th electric and magnetic constants are in complet agreement with those obtained by other methods.

L. PINCHERL

539.152

8129. Measurement of nuclear polarizabilities b nuclear scattering experiments. N. F. RAMSE Letter in *Phys. Rev.*, **83**, 659 (*Aug.* 1, 1951).

It is suggested that a study of deviations fro Rutherford scattering of nuclei by nuclei will provi a further measurement of polarizability of nucl independent of that already derived from sor phenomena in spectroscopic isotope shifts a quadrupole moment measurements. R. H. DALI

539.152

8130. Nuclear magnetic resonance measurements Be^9, Al^{27}, and Si^{29} in beryl. J. HATTON, B. V. ROLL AND E. F. W. SEYMOUR. Letter in *Phys. Rev.*, **83**, 6 (*Aug.* 1, 1951).

Five lines due to Al with quadrupole splitting 0·45 Mc/s between lines, three lines due to Be wi splitting 0·13 Mc/s and confirming spin 3/2, and o line of Si whence spin 1/2 and $\mu = 0{\cdot}55$ n.m. we observed. D. H. WHIFF

539.15

8131. Precise determination of the magnetic mom of the deuteron. B. SMALLER. *Phys. Rev.*, **83**, 812– (*Aug.* 15, 1951).

A precision measurement of the ratio of magnetic moment of the proton to that of deuteron has been carried out by the magne resonance method. The measurements were ma using mixtures of H_2O and D_2O and also mixtures H_2 and D_2 gas. The result for the $H_2O : D_2O$ mixt is $\mu_H/\mu_D = 3{\cdot}2571999 \pm 0{\cdot}0000012$, while for $H_2 : D_2$ mixture $\mu_H/\mu_D = 3{\cdot}2571990 \pm 0{\cdot}000001$

539.15

8132. The magnetic moment of S^{33}. S. S. DH MATTI AND H. E. WEAVER, JR. Letter in *Phys. R* **83**, 845 (*Aug.* 15, 1951).

Nuclear induction signals of S^{33} measured in were compared with those of N^{14} in HNO_3. Tak the known magnetic moment of N^{14} [Abstr. 2 (1951)] and spin of S^{33} as 3/2, $\mu(S^{33}) = +0{\cdot}64297$ $0{\cdot}00014$.

539.152.2

8133. The nuclear magnetic moment of praseodymium. D. WILLIAMS. Letter in *Phys. Rev.*, **83**, 858 (*Aug.* 15, 1951).

A nuclear magnetic resonance peak reported earlier [Abstr. 6685, 6689 (1950)] has now been found to be due to Rb contamination.

539.152.2 : 530.145

8134. A possible explanation for the deviations of nuclear magnetic moment from the Schmidt lines. H. MIYAZAWA. Letter in *Progr. Theor. Phys.*, **6**, 263–5 (*March–April*, 1951).

This could be due to the decrease of the intrinsic magnetic moment of a bound nucleon. An estimate using ps.-scalar meson theory with cut-off gives about the required magnitude. W. J. SWIATECKI

539.153

8135. On the solution of the Thomas–Fermi–Dirac equation. P. GOMBÁS AND R. GÁSPÁR. *Acta Phys. Hungarica*, **1** (*No.* 1) 66–74 (1951) *In German.*

The solution which minimizes the energy of the whole atom is found by a perturbation calculation starting from the solutions satisfying the Brillouin boundary conditions. L. PINCHERLE

539.153

8136. Solution of Thomas–Fermi–Dirac equation. P. GOMBÁS AND R. GÁSPÁR. Letter in *Nature, Lond.*, **168**, 122 (*July* 21, 1951).

An approximate solution is obtained for the equation of the statistical model of a bounded neutral atom, with the boundary conditions derived from the minimum energy principle, using Umeda's numerical solution [see Abstr. 1126 (1950)] of this equation (with different boundary conditions) as a starting-point. This solution then agrees within 2% with earlier numerical calculations over a wide range of atoms. R. H. DALITZ

539.153

8137. Asymptotic expression of the Thomas–Fermi function for a packed atom. K. UMEDA. Letter in *Phys. Rev.*, **83**, 651 (*Aug.* 1, 1951).

539.153

8138. Effects of nuclear motion on the fine and the hyperfine structure of hydrogen. II. T. ISHIDZU. *Progr. Theor. Phys.*, **6**, 154–65 (*March–April*, 1951).

For Pt I, see Abstr. 3706 (1951).

539.153

8139. Note on the doubly excited state of the negative hydrogen ion. E. HYLLERAAS. Note in *Astrophys. J.*, **113**, 704 (*May*, 1951).

Confirms the previously computed energy value of the $(2s)(2p)^3P$ state of H^- by further approximations. D. L. EDWARDS

539.153

8140. Asymptotic formula for stopping power of fast electrons. M. C. WALSKE AND H. A. BETHE. Letter in *Phys. Rev.*, **83**, 457 (*July* 15, 1951).

Corrects the expression previously derived by them. See Abstr. 8906 (1950). L. PINCHERLE

539.153

8141. On the structure of Te II. J. E. MACK, MURAKAWA, J. S. ROSS, F. A. PICK AND J. C. VAN DEN BOSCH. Letter in *Phys. Rev.*, **83**, 654 (*Aug* 1, 1951).

Energy levels, J, g and h.f.s. values, are given for a number of configurations. L. PINCHERLE

539.153

8142. Configuration interaction in Mn II. R. E. TREES. *Phys. Rev.*, **83**, 756–60 (*Aug.* 15, 1951).

The theoretical formulae for d^6 and d^5s are compared with the experimental data of Mn II. The relative positions of these configurations in Mn II allow the magnitude of configuration interaction to be determined accurately without the use of a least-squares calculation. Over-all agreement between theory and experiment is improved by the use of separate parameters in the two configurations and by the introduction of the effects of configuration interaction. The positions of the terms not yet known experimentally are predicted as a help in further analysis of this spectrum. The positions of terms of the d^5s configuration are believed to be predicted with better than usual accuracy by the use of a correction term proportional to $L(L+1)$. A.

539.153 : 535.215 : 537.561

8143. A comparison of theory and experiment for photo-ionization cross-sections. I. Neon and the elements from boron to neon. M. J. SEATON. *Proc. Roy. Soc. A*, **208**, 408–18 (*Sept.* 7, 1951).

The quantal theory of the continuous photo-electric absorption of radiation is briefly summarized, particular attention being given to the alternative formulae available and to the accuracy to be expected in practical calculations. Detailed calculations are described for the photo-ionization cross-section of Ne, using Hartree–Fock wave functions and the two formulae of the dipole length and the dipole velocity. The corresponding cross-sections are found to be $5{\cdot}8$ and $4{\cdot}4\times10^{-18}$ cm^2 at the spectral head and to rise slowly with increasing frequency until a broad maximum is reached for an energy of the ejected electron of about 11 eV. A comparison is made with previous calculations on the elements from B to Ne; the general trend of the results is discussed and improved estimates for B and F are given (10×10^{-18} and $4{\cdot}3\times10^{-18}$ cm^2 at the spectral head). A.

539.153 : 535.215 : 537.561

8144. A comparison of theory and experiment for photo-ionization cross-sections. II. Sodium and the alkali metals. M. J. SEATON. *Proc. Roy. Soc. A*, **208**, 418–30 (*Sept.* 7, 1951).

A summary is given of the results of experimental determinations of the atomic photo-ionization cross-sections of the alkali metals. Detailed calculations on Na are described, using Hartree–Fock wave functions, and it is shown that the theory is capable of reproducing the main features of the experimental results. A comparison with line-strength calculations is made, and the applicability of sum-rule tests is discussed. The finite minimum which is found experimentally in the cross-sections of certain of the alkali metals is attributed to spin-orbit perturbations of the free-electron wave functions. For Cs and Rb the theoretical calculation based on this effect is shown to give minima of a magnitude comparable to those

of the experimental results. The accuracy of previous calculations on the cross-sections of Ca II is discussed, use being made of sum-rule tests. A.

539.153 : 537.122

8145. Determination of the ratio of the $g_J^2(S_{\frac{1}{2}})$ values for potassium and hydrogen. The gyromagnetic ratio of the electron. W. B. POHLMAN, B. BEDERSON AND J. T. EISINGER. Letter in *Phys. Rev.*, **83,** 475 (*July* 15, 1951).

The atomic beam magnetic resonance method was used. The result, $g_J(K)/g_J(H) = 1{\cdot}00016 \pm 0{\cdot}00006$, combined with data obtained by other experimenters, leads to $g_J(H) = 2$ $(1{\cdot}00098 \pm 0{\cdot}00008)$ Bohr magnetons, which is 15 parts in 10^5 lower than the most accurate theoretical value. L. PINCHERLE

539.153 : 537.122

8146. The anomalous spin gyromagnetic ratio of the electron. S. KOENIG, A. G. PRODELL AND P. KUSCH. Letter in *Phys. Rev.*, **83,** 687 (*Aug.* 1, 1951).

A new determination using transitions between Zeeman levels of the h.f.s. of atomic H in a fixed magnetic field and a measurement of the precession frequency of protons in a water sample in the same field gives a value $g_S/g_L = 2(1{\cdot}001145 \pm 0{\cdot}000013)$ in complete agreement with the 4th-order calculation of Karplus and Kroll [Abstr. 3776 (1950)].

W. J. SWIATECKI

539.153.4

8147. Non-adiabatic transitions in hydrogen in rapidly alternating electric fields. R. RITSCHL. Letter in *Naturwissenschaften,* **38** (*No.* 9) 207–8 (1951) *In German.*

Quantum-mechanical calculations predicting the existence of non-adiabatic transitions between Stark-levels in H have been verified experimentally.

W. R. ANGUS

539.153.4 : 535.43

8148. Scattering of light by a bound electron with due regard to retardation. V. I. MAMASAKHLISOV. *J. Exp. Theor. Phys., USSR,* **20,** 1022–30 (*Nov.,* 1950) *In Russian.*

A calculation is made of the effective cross-section of light-scattering on a bound electron with consideration of retardation produced by the finite nature of the atomic system. The case is examined in which the scattering associated with retardation attains an appreciable value. An investigation is made of the resonance quadrupole scattering produced when the frequency of the incident quantum coincides with the frequency of transition of the atomic system, not allowed in the dipole but permitted in the quadrupole approximation. The effective cross-section of the resonance quadrupole scattering in some cases is of the order of magnitude of the square of the wavelength of the resonance radiation. BROOKHAVEN GUIDE TO RUSSIAN LITERATURE

539.155

8149. The masses of the substandards H^1, D^2, C^{12} and other light atoms. H. EWALD. *Z. Naturforsch.,* **6a,** 293–302 (*June,* 1951) *In German.*

New measurements on 18 mass-spectrographic doublets are tabulated and their relation to older values discussed. New masses follow for n, H^1, D^2, He^4, $C^{12,13}$, $N^{14,15}$, $O^{17,18}$, F^{19}, $Ne^{20,21,22}$, Si^{28}, P^{31}, $S^{32,34}$ and A^{40}. W. J. SWIATECKI

539.155

8150. Masses of krypton-82, -84 and -86 and xenon-129 and -132. C. L. KEGLEY AND H. E. DUCKWORTH. Letter in *Nature, Lond.,* **167,** 1025 (*June* 23, 1951).

These were measured by the doublet method using a Dempster-type double-focusing mass spectrometer. The values obtained for the masses and the packing fractions are given, and the latter compared with Aston's values. J. HUGHES

539.155

8151. The mass-differences $C^{12}(H^1)_4$–O^{16}, $C^{12}(H^1)_2$–N^{14}, and $C^{12}(H^1)_3$–N^{15}. K. OGATA AND H. MATSUDA. Letter in *Phys. Rev.*, **83,** 180 (*July* 1, 1951).

Improvements in the Osaka University mass spectrograph are described and measurements of the above mass differences and those for the corresponding molecular-molecular doublets are discussed.

W. H. DENTON

539.15

8152. Masses of light nuclei from nuclear disintegration energies. C. W. LI, W. WHALING, W. A. FOWLER AND C. C. LAURITSEN. *Phys. Rev.*, **83,** 512–1 (*Aug.* 1, 1951).

Values of the atomic masses from n^1 to F^{20} have been derived from the Q-values of nuclear reactions with a procedure of statistical adjustment. Tables are given of several fundamental mass differences, the most probable Q-values, and the atomic masses. Some disparity with the mass spectroscopic results is noted.

539.155.2 : 535.343.4–1

Determination of isotope ratios by an infrared absorption method. *See Abstr.* 7754

RADIOACTIVITY . α-, β- AND γ-RAYS 539.1

539.16 : 539.172

8153. Concentration of ores by induced activities. F. E. SENFTLE AND A. M. GAUDIN. *Nucleonics,* 53–9 (*May,* 1951).

The possibility of sorting minerals by observation of neutron-induced activities is examined. The initial activities which may be induced by a given thermal neutron flux in a number of elements and important minerals are tabulated and the merits of the various available neutron sources which might be used for this purpose are reviewed. L. R. SHEPHERD

539.16.

8154. Quantitation of alpha emitters in bone. B. L. MILLER AND F. E. HOECKER. *Nucleonics,* 44–52 (*May,* 1951).

Describes a method of estimating the ratio Ra/Rn activities in bone tissue, using a photographic plate method. This depends on the ranges of Ra and Rn α particles being less than those of the short-period RaA and RaC′, so that it is possible to filter out the former by interposing an Al foil between source and the recording plate. The method involves

counting tracks in the emulsions exposed in a carefully defined geometry with and without the Al filter. Results obtained with bone tissue of a rat injected with Ra indicated a net loss of 60% of the Rn from the bone section examined. L. R. SHEPHERD

539.16.08

8155. A direct reading meter for the measurement of highly active samples of gamma-emitting radioisotopes. W. K. SINCLAIR AND S. P. NEWBERY. *J. Sci. Instrum.*, **28**, 234–6 (*Aug.*, 1951).

The meter incorporates an ionization chamber and a d.c. amplifier. The source is placed within the chamber annulus and the operator is protected from it by 4 cm of Pb. The instrument has been calibrated for a number of gamma-emitting isotopes, and samples ranging from 2 mg to over 200 mg Ra equivalent may be quickly and safely measured. A.

539.162

8156. Angular correlation in the triple cascade transitions. L. C. BIEDENHARN, G. B. ARFKEN AND M. E. ROSE. *Phys. Rev.*, **83**, 586–93 (*Aug.* 1, 1951).

The theory of the angular correlation between the radiations involved in 3 successive nuclear transitions is presented. The formalism is applicable to the case of 3 successively emitted radiations as well as to the case in which one of the emission processes is replaced by an absorption process. Thus, applications are made to (1) the emission of 3 cascade gamma-rays and (2) to the double-cascade gamma-emission following capture of particles with non-zero orbital angular momentum. In some cases the angular correlation depends on the order of the transitions. Under process (2), special results are presented which are applicable to $B^{11}(p, \gamma, \gamma)C^{12}$. It is also pointed out that the formalism properly describes the angular correlation in all processes wherein 3 directions are specified and is therefore applicable when one of these directions refers to a polarization state while the other 2 refer to propagation vectors. Results are given for the limitation on anisotropy for the triple cascade transition with 2 radiations parallel or antiparallel and for 2 radiations in cascade with intervening radiations unobserved. A.

539.163

8157. The radiations of ^{203}Hg as observed by a new method. H. W. WILSON AND S. C. CURRAN. *Phil. Mag.*, **42**, 762–74 (*July*, 1951).

The radioactivity of Hg has been investigated by a new way which makes use of the integrating properties of a proportional counter with an internal source. These show that the β spectrum is of allowed shape from 20 keV to the end point which was found to be 210 keV ± 5 keV. The energy and internal conversion coefficients of the γ-ray which follows the β-emission have been evaluated. Also the half-life has been determined as 45·9 ± 0·5 days. A discussion of the decay scheme and further possible use of the technique including its extension to scintillation counters concludes the paper. A.

539.163

8158. The alpha-activity of natural bismuth. H. BRAGGI AND A. BERTHELOT. *C.R. Acad. Sci., Paris*, **232**, 2093–5 (*June* 4, 1951) *In French.*

Ilford C2 nuclear emulsions loaded with 0·27 g/cm³ of Bi were kept at 4°C for 2¼ yr and then examined for single α-particle tracks and stars along with control emulsions kept under the same conditions. Short α-particle tracks of energy 3·15 MeV and range in air 1·85 cm were found in the loaded emulsions, and attributed to Bi^{209}, with a ½-life of $2{\cdot}7 \times 10^{17}$ yr. It is suggested that these may be the cause of the unidentified pleochroic halo "K" [Henderson, *Proc. Roy. Soc. A*, **173**, 250 (1939)] which corresponds to a range in air of 1·8 cm. A. O. STANESBY

539.163.1

8159. Coincidence methods of measuring disintegration rates of radioactive sources. J. BARNÓTHY AND M. FORRO. *Rev. Sci. Instrum.*, **22**, 415–23 (*June*, 1951).

Errors, possibly rising to 30%, due to the following causes, are discussed, and means to avoid or evaluate them are given: angular correlation effects; gamma-sensitivity of beta-counters; scattered gamma-rays; fluctuations of resolving time and background. Corrections amounting to 0·35% were applied to the experimentally determined disintegration rate of a standard Co^{60} γ-ray source, giving a final value of $(1{\cdot}057 \pm 0{\cdot}030) \times 10^5$ disintegrations/sec. F. R. HOLT

539.163.1

8160. The half-life of tritium by absolute counting. W. M. JONES. *Phys. Rev.*, **83**, 537–9 (*Aug.* 1, 1951).

Results of a measurement of the half-life of T by absolute counting are presented. The method consisted of the mass spectrometric analysis of a H–T mixture enriched in T, the dilution of some of this material with H in a known way to a countable level of activity, and the counting of a portion of the diluted gas in a Geiger counter of known effective volume. The half-life was found to be 12·41 with uncertainties of plus 0·15 and minus 0·25 yr. A.

539.163.1

8161. Measurement of the ratio of the activities of U^{235} and U^{234} in natural uranium by means of an ionization chamber with a grid. G.-J. SAYAG. *C.R. Acad. Sci., Paris*, **232**, 2091–3 (*June* 4, 1951) *In French.*

The ratio $N_{235}/N_{234} = (4{\cdot}08 \pm 0{\cdot}15)\%$ was obtained, giving a value for the lifetime of U^{235} of $7{\cdot}07 \times 10^8$ yr. J. HUGHES

539.163.2

8162. Radioactivity of F^{17}. V. PEREZ-MENDEZ AND P. LINDENFELD. Letter in *Phys. Rev.*, **83**, 864 (*Aug.* 15, 1951).

See Abstr. 2947 (1951). Fresh experiments indicate that F^{17} emits no nuclear γ-rays.

539.163.2

8163. Erratum: Radioactivity of Ag^{111}, Cd^{111}, In^{111} and Sn^{111}. C. L. MCGINNIS. Letter in *Phys. Rev.*, **83**, 651 (*Aug.* 1, 1951). See Abstr. 4652 (1951).

539.164.74

8164. The line-form of the resonance scattering of α-particles. H. MARSCHALL AND D. WISKOTT. *Z. Phys.*, **129** (*No.* 6) 619–25 (1951) *In German.*

The variation of the line-form with scattering angle is calculated from the results of an earlier theory [Abstr. 2965 (1951)]. The curves are derived by a simple graphical construction. G. J. KYNCH

539.165

8165. The beta spectrum of tritium. G. M. INSCH AND S. C. CURRAN. *Phil. Mag.*, **42**, 892–9 (*Aug.*, 1951).

This has been carefully examined by the proportional counter method down to energies ~ 1 keV. In the present work it has been more thoroughly explored using improved techniques designed to permit accurate measurements of the spectrum shape down to a lower energy limit ~ 200 eV. The improvements consisted chiefly in employing a counter which was made "end-free" by means of field-adjusting tubes and the use of an electronic method of measuring the pulse distribution in addition to the moving film technique. The intensity of the spectrum below 1 keV was found to be definitely less than theoretically predicted. A.

539.165, 539.166

8166. Beta and gamma radiation. I–III. J. V. JELLEY. *Atomics*, **1**, 313–18 (*Nov.*, 1950); **2**, 5–12 (*Jan.*); 191–210 (*July*, 1951).

An elementary review of the origin and properties of β- and γ-radiation, together with an outline of experimental methods of measuring their energies.

539.165, 539.166

8167. The coincidence measurements of the beta and gamma radiations of Cu^{64}. S. MERIÇ. *Istanbul Univ. Fen Fak. Mec., Ser. A*, **16**, 51–69 (*Jan.*, 1951).

These show evidence of a correlation of γ's with β^+ but not with β^-. The apparent energy-independence of the coincidence rate suggests that the γ is of nuclear origin, but this is difficult to reconcile with the known Fermi distribution of Cu^{64}.

W. J. SWIATECKI

539.165, 539.166

8168. Spectrometry of β- and γ-rays from artificial radioactive substances. N. MARTY. *J. Phys. Radium*, **12**, 621–30 (*May*, 1951) *In French.*

A general review with 74 refs., which mentions several types of β-spectroscope, discusses source deposition and describes with examples the Compton-electron method of measuring γ-ray energies and the methods of studying simple and complex β-spectra.

J. C. E. JENNINGS

539.165, 539.166

8169. Radiations from F^{18}, Mo^{93} and Cl^{34}. L. RUBY AND J. R. RICHARDSON. *Phys. Rev.*, **83**, 698–700 (*Aug.* 15, 1951).

The positron spectrum of F^{18} was investigated with a magnetic lens spectrometer and found to be of the allowed type with an upper limit at 649 ± 9 keV. The gamma-radiation from Mo^{93} was found to consist of 3 lines at 262 ± 2 keV, 692 ± 11 keV and $1{\cdot}51 \pm 0{\cdot}035$ MeV. The K to L conversion ratio for the low-energy line indicates 2^5 pole electric radiation. The positron spectrum of Cl^{34} consists of 3 components with upper limits at 4·45, 2·6 and 1·3 MeV. Gamma-ray lines were found at 3·3 and 2·1 MeV and at $0{\cdot}145 \pm 0{\cdot}003$ MeV. The latter line gives rise to internal conversion electrons. A.

539.165 : 539.166

8170. Coincidence studies of the disintegration of neodymium (147), cerium (144), praseodymium (144) and cerium (143). C. E. MANDEVILLE AND E. SHAPIRO. *Proc. Nat. Inst. Sci. India*, **17**, 45–56 (*Jan.–Feb.*, 1951).

The characteristic radiation energies and coincidence rates of some radionuclides have been determined by conventional absorption and coincidence methods. Beta-ray energies have been measured by Al absorption and Feather analysis, and the resulting end-points evaluated in terms of energy by Feather's equation. Gamma-ray energies were determined by absorption in Pb, and in the case of soft quanta in the X-ray region, by absorption in Al and Pb, and by critical absorption. Beta-beta, beta-gamma and gamma-gamma coincidence measurements were carried out when possible. A.

539.165.2

8171. Theory of a double β-decay. L. A. SLIV. *J. Exp. Theor. Phys., USSR*, **20**, 1035–8 (*Nov.*, 1950) *In Russian.*

A calculation is made of the probability of a double β-decay for an even-even nucleus. It is shown that the electron spectra is the same for all variants of interaction. The mean life of a nucleus for such a decomposition is of the order 10^{18} yr.

BROOKHAVEN GUIDE TO RUSSIAN LITERATURE

539.165.2

8172. The relative phase of the interaction constants for mixed invariants in beta-decay. L. C. BIEDENHARN AND M. E. ROSE. Letter in *Phys. Rev.*, **83**, 459 (*July* 15, 1951).

Time reversal invariance requires this to be 0 or π so that the assumption of real constants is no restriction. W. J. SWIATECKI

539.165.2

8173. A reduction of arbitrariness in the theory of forbidden β-spectra. C. L. LONGMIRE AND A. M. L. MESSIAH. Letter in *Phys. Rev.*, **83**, 464 (*July* 15, 1951).

This is achieved by using the invariance of the nuclear Hamiltonian under space rotations and time reversal. W. J. SWIATECKI

539.166

8174. Cloud chamber study of the xenon isotopes Xe^{133}, Xe^{135}. H. BEHRENS. *Z. Naturforsch.*, **6a**, 249–51 (*May*, 1951) *In German.*

The excitation following β-decay of isotopes of Xe formed in fission was determined by measurements of internal conversion electrons starting at the point of origin of the decay electrons. J. G. WILSON

539.166

8175. A study of the γ-rays emitted by Au^{198} using a spectrometer. P. HUBERT. *C.R. Acad. Sci., Paris*, **232**, 2201–3 (*June* 11, 1951) *In French.*

A lens spectrometer with a collecting power of 2·5% and a resolving power of 3·3% was used to measure the photoelectrons from a lead radiator. Three γ-rays of energy, 411 ± 2, 673 ± 3 and 1075 ± 7 keV, were found, and from their relative intensities a level scheme is proposed. J. HUGHES

539.166

8176. Explicit γ-γ angular correlations. S. P. LLOYD. *Phys. Rev.*, **83**, 716–20 (*Aug.* 15, 1951).

The theoretical γ-γ directional correlation function is given as a Legendre series: $W(\theta) = 1 + \Sigma A_L P_L(\cos\theta)$

for those cases where the γ-rays are emitted with the lowest angular momentum allowed by selection rules. The coefficients A_L are given algebraically and are also tabulated as four-place decimals for all cascades up to 2^4-pole—2^6-pole in which the largest nuclear spin does not exceed nine. Rules are given for obtaining from the tables: (*a*) the lowest order multipole mixture interference terms, (*b*) certain α-γ and α-α directional correlations. A.

539.166 : 539.172.4

8177. Neutron capture γ-rays from fluorine, sodium, magnesium, aluminium and silicon. B. B. KINSEY, G. A. BARTHOLOMEW AND W. H. WALKER. *Phys. Rev.*, **83**, 519–34 (*Aug.* 1, 1951).

The energies and the absolute intensities of the γ-rays produced by neutron capture in F, Na, Mg, Al and Si have been measured with the aid of a pair-spectrometer. Direct transitions to the ground states of the product nuclei are predominant in the γ-ray spectra of F and Al. The neutron binding energy in F^{20} is $6{\cdot}63 \pm 0{\cdot}03$ MeV and in Al^{28}, $7{\cdot}724 \pm 0{\cdot}010$ MeV. The γ-ray representing the direct transition to the ground state of Na^{24} was not detected. The interpretation of the Mg spectrum presents some difficulties. A weak γ-ray with the binding energy of a neutron in Mg^{25} was detected but none could be found to correspond to the direct transition to the ground state in Mg^{26}. In Si, most captures are due to Si^{28} which produces Si^{29} by the emission of two γ-rays in cascade. Very weak γ-rays representing direct transitions to the ground states in Si^{29} and Si^{30} were detected. Their energies are $8{\cdot}51 \pm 0{\cdot}04$ (Si^{29}) and $10{\cdot}55 \pm 0{\cdot}05$ MeV (Si^{30}). A.

539.166 : 541.15

A cobalt gamma-ray source used for studies in radiation chemistry. *See Abstr.* 8307

539.166.74

8178. Absorption of 280-MeV photons. J. W. DEWIRE, A. ASHKIN AND L. A. BEACH. *Phys. Rev.*, **83**, 505–9 (*Aug.* 1, 1951).

Total cross-sections for 280 MeV photons have been measured for a number of elements. The source of photons was the bremsstrahlung spectrum of 310 MeV upper limit, which was obtained from the Cornell synchrotron. Photons above 250 MeV were detected by a pair-spectrometer and the transmission through various samples determined. The measured cross-sections in units of cm^2/g are 0·01060, 0·0284, 0·0528, 0·0776, 0·1069 and 0·1148 for Be, Al, Cu, Sn, Pb and U, respectively. The probable statistical errors range from 0·9 to 1·4%. These values are lower than the theoretical values by a fraction which is roughly proportional to Z^2 and is about 10% for Pb, in agreement with other results obtained at lower energies. A.

539.166.835

8179. On the angular distribution of electron pairs created in lead by gamma-rays of ThC″. A. Z. HRYNKIEWICZ. *Acta Phys. Polon.*, **10** (*No.* 3–4) 251–60 (1951).

The angular distribution of electron pairs created in Pb by γ-rays of ThC″ has been measured by the method of the G.M. counters. The results do not agree with the theory of Bethe and Heitler, and seem to indicate that the Born approximation used in that theory is not adequate to the problem in question A.

NUCLEAR REACTIONS 539.17

539.17

8180. Polarized nuclear reactions. R. J. BLIN-STOYLE. *Proc. Phys. Soc., Lond. A*, **64**, 700–11 (*Aug.*, 1951).

Using properties of states of quantized angular momentum, general formulae are obtained for the angular distribution in nuclear reactions and scattering processes in which the bombarding particles and target nuclei are polarized. A simple symmetrical formula for use in specific calculations is given. The following cases are considered in detail: (*a*) polarized bombarding particles only, (*b*) target nuclei polarized in a magnetic field and bombarded by polarized particles. Finally, general predictions are made concerning the polarization of particles resulting from any reaction or scattering process and the results applied to the *d*–*d* reaction which is suggested as a source of fast polarized neutrons and protons. A

539.17

8181. On the Goldberger model for the interaction of high energy nucleons with heavy nuclei. G. BERNARDINI, E. T. BOOTH AND S. J. LINDENBAUM. Letter in *Phys. Rev.*, **83**, 669 (*Aug.* 1, 1951).

Using the published *n*–*p* and *p*–*p* scattering data, the cascade process in a heavy nucleus due to an incident 400 MeV nucleon is followed by the Monte Carlo method in the style of Goldberger [Abstr. 1178 (1949)]. The energy distribution found for the outgoing particles agrees well with the experimental data. R. H. DALITZ

539.17 : 541.126

Chemical ignition of thermal nuclear reactions. *See Abstr.* 8288

539.17 : 778.34

8182. The wire method of loading nuclear emulsions. G. MEULEMANS, G. P. S. OCCHIALINI AND A. M. VINCENT. *Nuovo Cim.*, **8**, 341–4 (*May*, 1951).

Many substances can be obtained in wires or threads of a few microns thickness, and these can be embedded in the emulsion, giving a geometry superior to foils, though inferior to embedded grains. The emulsion is poured over a grid of parallel wires in tension, and measurements on tracks show that distortion of the emulsion becomes negligible at a distance of roughly 30 μ from the wires.

539.17 : 778.34

8183. On the study of highly ionizing particles in nuclear plates. G. BELLIBONI AND M. MERLIN. *Nuovo Cim.*, **8**, 349–56 (*May*, 1951) *In Italian.*

A method consisting in matching measurements of mean scattering deviation and gap-length density along the nuclear tracks. By using only one diagram, where the gap-length densities for the "black" tracks as well as the grain density for the "grey" tracks are given *v.* mean scattering deviation, it is possible to distinguish both high and low energy particles. The

corrections to be taken into account for fading have also been considered. A.

539.172

8184. The effect of the Hartree potential in nuclear transitions. E. M. PURCELL AND K. T. BAINBRIDGE. Letter in *Phys. Rev.*, **83**, 656 (*Aug.* 1, 1951).

In nuclear transitions involving net gain or loss of charge in an atom, a modification of the Q value is necessary to include the work done by the atomic field on the outgoing charge. R. H. DALITZ

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 8009–15

539.172.11 : 539.185

8185. Energy spectrum of neutrons from a thorium active deposit—beryllium source. D. A. BROMLEY. *Canad. J. Phys.*, **29**, 129–36 (*March*, 1951).

The energy spectrum of the neutrons emitted when beryllium is bombarded with alpha-particles from Th (C + C′) has been determined by measuring the ranges and directions of recoil of protons produced in a cloud chamber by the neutrons. The maximum energy of the neutrons was found to be about 15·5 MeV, within experimental error of the calculated maximum, 14·4 MeV. Many neutrons were found with energy of about 2·15 MeV and the structure in the remainder of the spectrum can be attributed to the existence of energy levels in C^{12} at about 7·1 and 4·5 MeV. The angular distribution of the protons scattered by the neutrons from this source was isotropic to within experimental error. A.

539.172.13

8186. A comparison of several nuclear absolute voltage determinations. W. J. STURM AND V. JOHNSON. *Phys. Rev.*, **83**, 542–7 (*Aug.* 1, 1951).

An evaluation of the consistency between the absolute voltage determination of the threshold energy of the $Li^7(p, n)Be^7$ reaction as measured by Herb, Snowdon and Sala and earlier independent absolute alpha-particle energy measurements has been made. The experimental comparison was affected by employing the natural alpha-particles from Po and Ra C′, the energy of which has been measured absolutely by several authors using magnetic deflection methods. In this experiment the alpha-particles from these substances have been electrostatically deflected in the 90° cylindrical electrostatic analyser at the University of Wisconsin. Alpha-particle line measurements were analysed by numerical integration of resolution and source functions and in themselves contributed negligibly to the uncertainties of the comparison. The resulting alpha-particle energies, evaluated by comparison with the energy of the $Li^7(p, n)Be^7$ threshold, agree with earlier measurements, and indicate that within the limits of accuracy of the experiments, all determinations give identical results. A.

539.172.13 : 537.534.72

8187. Excitation functions with an internal cyclotron beam. N. M. HINTZ. Letter in *Phys. Rev.*, **83**, 185 (*July* 1, 1951).

The 100 MeV proton beam is deflected by multiple Coulomb scattering in a thin Ta foil, and focused by the cyclotron field on targets 1 in away from the median plane. If 180° focusing is used, a stacked foil target intercepts 0·5% of the total beam with an energy spread of 0·5 MeV. 360° focusing gives 7·5% efficiency. Results with Al targets are given. The beam is monitored with polystyrene foils. F. R. HOLT

539.172.13

8188. The scattering of 10·4-MeV deuterons by hydrogen. L. ROSEN AND J. C. ALLRED. *Phys. Rev.*, **82**, 777–82 (*June* 15, 1951).

The $d-p$ elastic scattering cross-section has been measured in the angular region 30–160° CM (centre-of-mass system) by means of a nuclear multiple photographic plate camera. Thin hydrogen gas targets were bombarded by the deuterons from the Los Alamos cyclotron, the incident deuteron energy at the centre of the reaction volume being 10·4 MeV. Values of the scattering differential cross-section are given within an absolute standard error of ± 3% in the range 40–140° CM and to ± 5% in the remainder of the angular range observed. Results of this measurement are in good agreement with previously reported data. The estimated total nuclear cross-section, $1{\cdot}5 \times 10^{-24}$ cm^2, is essentially that observed for the $n-d$ collision at the same centre of mass energy. A least-squares curve fit indicates S-, P- and D-wave interactions to be present at this energy. A.

539.172.13

8189. Angular distribution of protons from the D(d, p)T reaction at 10·3-MeV bombarding energy. J. C. ALLRED, D. D. PHILLIPS AND L. ROSEN. *Phys. Rev.*, **82**, 782–5 (*June* 15, 1951).

The differential cross-section of the D(d, p)T reaction for 10·3 MeV bombarding deuterons has been measured by a nuclear emulsion technique using a multiple nuclear-plate camera. Values of the cross-section are given over essentially the entire range of the centre-of-mass angle. The results are fitted within experimental error by the expression:

$$\sigma(\cos\Omega) = 6{\cdot}24P_0 + 8{\cdot}28P_2 + 13{\cdot}16P_4 + 8{\cdot}24P_6 + 2{\cdot}31P_8$$

where Ω is the centre-of-mass angle, σ is expressed in millibarns per unit solid angle, and the P_i's are Legendre polynomials. For angles between 20° and 160° the average r.m.s. absolute standard error is ± 3·8%. For angles greater than 160° and less than 20° this error approaches ± 5%. A.

539.172.13

8190. The D—He^4 interaction for 10·3-MeV deuterons. J. C. ALLRED, D. K. FROMAN, A. M. HUDSON AND L. ROSEN. *Phys. Rev.*, **82**, 786–90 (*June* 15, 1951).

Elastic scattering and disintegration of 10·3 MeV deuterons bombarding He^4 have been studied by means of a multiple nuclear plate camera. The reaction $D + He^4 \rightarrow He^4 + p + n - 2{\cdot}2$ MeV was observed with a total cross-section of 0·3 ± 0·1 barn. The protons show a marked tendency to emerge in the forward direction, and there is some, not very strong, evidence for the formation of He^5 as an intermediate product. The differential elastic scattering cross-section was measured at intervals of 2·5

in the laboratory system from 12·5° to 140°. The shape of this cross-section curve can be inferred from the following approximate values (angles in centre-of-mass system and differential cross-sections in millibarns per unit solid angle): 29·4°, 186; 58·4°, 9·7; 97·7°, 69; 129·3°, 37; 157·4°, 82·4. A.

539.172.13

8191. Angular distributions of protons from the reaction $^{12}C(d, p)^{13}C$. J. ROTBLAT. Letter in *Nature, Lond.*, **167**, 1027–8 (*June* 23, 1951).

These are presented graphically, and were determined using photographic plates. Spin and parity assignments are made for the ground and first excited level of C^{13}. J. HUGHES

539.172.13

8192. Angular correlation between neutron and γ ray in the disintegrations $Li^7(dn)Be^{8*}(\gamma)Be^8$ and $Li^6(dn)Be^{7*}(\gamma)Be^7$. J. THIRION. *C.R. Acad. Sci., Paris*, **233**, 37–8 (*July* 2, 1951) *In French.*

These were measured using scintillation detectors and allow certain spin assignments [e.g. ½ for Be^{9*}, 1 for Be^{8*} (4·9 MeV), ½ for Be^{7*} (434 keV)]. W. J. SWIATECKI

593.172.13

8193. Excited states of Si^{29} from an investigation of the $P^{31}(d, \alpha)Si^{29}$ and $Si^{28}(d, p)Si^{29}$ reactions. P. M. ENDT, D. M. VAN PATTER, W. W. BUECHNER AND A. SPERDUTO. *Phys. Rev.*, **83**, 491–4 (*Aug.* 1, 1951).

The alpha-particle groups from a thin target of zinc phosphate bombarded by 1·81 MeV deuterons have been studied with a high resolution magnetic spectrograph. Eight of the alpha-groups observed have been assigned to the previously unreported $P^{31}(d, \alpha)Si^{29}$ reaction, corresponding to the ground state and 7 excited states of Si^{29} in a region of excitation of 0 to 5 MeV. From a similar investigation of the proton groups from thin targets of silicon dioxide bombarded by 1·81 MeV deuterons, 10 $Si^{28}(d, p)Si^{29}$ proton groups were observed, corresponding to the ground state and 9 excited states of Si^{29}. The positions of the excited states found from the $P^{31}(d, \alpha)Si^{29}$ reaction agreed within the experimental error with those obtained from the $Si^{28}(d, p)Si^{29}$ reaction. The excited states observed in Si^{29} are at 1·282, 2·038, 2·436, 3·073, 3·623, 4·078, 4·840, 4·897 and 4·934 MeV. A.

539.172.13

8194. (d, n) Reactions with 15-MeV deuterons. I. Angular distributions. C. E. FALK. *Phys. Rev.*, **83**, 499–504 (*Aug.* 1, 1951).

Nine elements are bombarded with 15 MeV deuterons from a cyclotron. The resulting angular distributions of 9·25 to 13·1 MeV neutrons are measured by means of a four-proportional counter telescope and also by threshold detectors. It is observed that all the measured angular distributions are peaked in the forward direction, some showing a peak at 0° and others peaks at 10–15° with respect to the deuteron beam. Different methods of production of neutrons from (d, n) reactions are discussed, and it is shown that most of the observed neutrons are produced by a stripping process. A.

539.172.13

8195. Angular distribution of neutrons from targets bombarded by 20-MeV deuterons. L. SCHECTER. *Phys. Rev.*, **83**, 695–7 (*Aug.* 15, 1951).

The distributions are found to have a structure which is characteristic of the particular process which produces the neutrons. In some cases, small-angle structure appears, and these cases have been analysed by applying the theory of S. T. Butler [Abstr. 3016 (1951)]. Parities and possible spin values have been assigned to the states of the final nuclei which are produced in the reactions. A.

539.172.13

8196. Gamma-rays from deuteron bombardment of B^{10}, B^{11}, N^{14} and F^{19}. J. TERRELL AND G. C. PHILLIPS. *Phys. Rev.*, **83**, 703–8 (*Aug.* 15, 1951).

A pair-spectrometer has been used to analyse the high-energy gamma-ray spectra produced by bombarding thick targets of natural B, enriched B, N and F with 1·56 MeV deuterons from a Van de Graaff generator. The $B^{10} + d$ spectrum shows gamma-rays of energy 4·52 ± 0·10, 6·71 ± 0·13 and 9·04 ± 0·18 MeV; the spectrum from $B^{11} + d$, partially masked by the strong $B^{10} + d$ gamma-rays, shows a single 4·5 ± 0·1 MeV gamma-ray. The N target produced strong gamma-rays of energy 5·33 ± 0·11, 7·40 ± 0·15 and 8·46 ± 0·17 MeV, with some indication of unresolved lines at 4·4 and 6·4 MeV. The $F^{19} + d$ spectrum shows weak high-energy gamma-rays, not previously observed, of energy 8·1 ± 0·4, 9·3 ± 0·3 and 11·5 ± 0·4 MeV; a level in Ne^{20} at 11·5 ± 0·4 MeV is indicated. In any of these spectra lower energy gamma-rays may be present though undetected, because of the large variation of spectrometer sensitivity with energy. Absolute yield values are estimated for each of these gamma-rays. A.

539.172.3

8197. On the nuclear photoeffect in beryllium. O. BERGMANN. *Acta Phys. Austriaca*, **4** (*No.* 4) 338–54 (1951) *In German.*

Expressions for the cross-section of the (γ, n) reaction in Be^9 are obtained, treating the odd neutron as moving in the field of a potential well. With radius 5×10^{-13} cm, the depth of the well must be 12·09 MeV for the ground state to give the correct threshold for the reaction, and must be taken as 3·3 MeV in the free *S*-state in order to give agreement with the experimental cross-section. R. H. DALITZ

539.172.3 : 539.18

8198. On the production of mesons by X-rays. K. AIDZU, Y. FUJIMOTO AND H. FUKUDA. *Progr. Theor. Phys.*, **6**, 193–6 (*March–April*, 1951).

The cross-sections for the processes $p + \gamma \rightarrow n + \pi^+$ or π^0, $n + \gamma \rightarrow n + \pi^0$, calculated taking into account the anomalous magnetic moment of the nucleon in a phenomenological way, and using scalar or ps.-scalar mesons, are compared with experiment. W. J. SWIATECKI

539.172.3 : 539.18

8199. Low energy photomeson production in hydrogen. S. D. DRELL. *Phys. Rev.*, **83**, 555–60 (*Aug.* 1, 1951).

Berkeley experiments have revealed the general

features of the neutral and charged π-meson photoproduction cross-sections for gamma-rays incident on protons. In particular, approximate equality of the π^0 and π^+ production cross-sections has been observed. This has proved difficult to account for theoretically. Calculations based on a weak-coupling perturbation treatment of the meson-nucleon interaction predict the π^0 production to be reduced by $\sim(\mu/M)^2$ relative to π^+ production for energies at which the Berkeley experiments are performed ($\sim$ 320 MeV). In this paper the perturbation theory approximation of weak nucleon-meson coupling is avoided. By means of a canonical transformation of the type introduced by Bloch and Nordsieck, a solution is obtained to the Hamiltonian equation that involves no assumption concerning the largeness or smallness of $g^2/4\pi$. The approximations involved are neglect of nucleon recoil and treatment of spin and charge matrices as classical unit vectors. Handling the electromagnetic field by standard perturbation theory, this solution is used to calculate the matrix elements for photoproduction. In evaluating the matrix elements a finite source cut-off must be used to compensate neglect of nucleon recoil. Qualitative agreement with the observed equality of π^0 and π^+ production cross-section is obtained with a choice of $g^2/4\pi \simeq 1 - 2$ and of source radius of the order of a nucleon Compton wavelength. Calculation of the anomalous nucleon magnetic moments corroborates a choice of these constants in this range. An angular distribution and energy dependence for the production cross-sections in accord with observation are obtained. A.

539.172.3 : 539.18

8200. Production ratio of photomesons from beryllium. H. A. MEDICUS. Letter in *Phys. Rev.*, **83,** 662 (*Aug.* 1, 1951).

The $-/+$ ratio found in the range 30 to 70 MeV at 90° to the beam was 2·2. E. P. GEORGE

539.172.3 : 539.18

8201. The contribution of the Pauli moment to π-meson production by photons. M. F. KAPLON. *Phys. Rev.*, **83,** 712–15 (*Aug.* 15, 1951).

The photon-nucleon production of π-mesons has been calculated incorporating in the interaction a Pauli-type term representing the interaction of the photon with the anomalous magnetic moments of the nucleons. The effect of the added interaction for the scalar theory is to increase somewhat the charged meson production while leaving the neutral production virtually unchanged. For the pseudoscalar theory the charged meson production is relatively unaffected while the neutral meson production is greatly enhanced. Comparison with the neutral meson experiments in hydrogen therefore favours the pseudoscalar theory. A.

539.172.4

8202. An attempt to detect the reaction $C^{14}(n, \gamma)C^{15}$. L. YAFFE AND W. H. STEVENS. *Canad. J. Phys.*, **29,** 186–92 (*March*, 1951).

No activity ascribable to C^{15} could be found. If the β-ray energy of $C^{15} > 3$ MeV and the half-life lies between 1 sec and 1 min, the capture cross-section for the reaction < 1 microbarn. A.

539.172.4

8203. On the selective absorption of thermal neutrons in selenium and arsenium. J. A. JANIK. *Acta Phys. Polon.*, **10** (*No.* 3–4) 261–9 (1951).

Measurements were made of thermal neutron cross-sections in Se and As. Photoneutrons from a Ra + Be source of strength 100 mg Ra were used. The variation of these cross-sections with energy of the incident neutrons was investigated and interpreted as an interference effect in the microcrystals of Se and As. A.

539.172.4

8204. On the scattering of fast neutrons from Li–D reactions. T. WAKATSUKI AND K. SUGIMOTO. *J. Phys. Soc. Japan*, **6,** 157–63 (*May–June*, 1951).

Total scattering cross-sections for 37 elements have been measured for heterogeneous fast neutrons of mean energy 6·5 MeV. Irregular variations of cross-sections with atomic weights were observed at magic number nuclei but they were not all smaller than the neighbouring nuclei as is the case for inelastic scattering or capture processes. It is probable that elastic scattering cross-sections become large at those nuclei. Another large irregular variation of cross-section was found at Ti. A.

539.172.4

8205. The measurement of the cross-section for the absorption of slow neutrons by several elements by modulating a pile. B. GRIMELAND, E. HELLSTRAND AND F. NETTER. *C.R. Acad. Sci., Paris*, **232,** 2089–91 (*June* 4, 1951) *In French.*

The thermal neutron absorption cross-section for Li, Cl, V, Cr, Mn, Fe, Co, Ni and Cu was measured accurately. The result obtained for Hg indicates an anomalous variation of the absorption with neutron velocity. J. HUGHES

539.172.4

8206. Measurements of thermal neutron absorption by the modulation of a pile. P. BENOIST, L. KOWARSKI AND F. NETTER. *J. Phys. Radium*, **12,** 584–9 (*May*, 1951) *In French.*

By modulating the neutron density inside a pile by periodically passing a sample of the absorber in and out of the pile the effective cross-sections can be measured. Preliminary results for B, Al, La, Y : 710, 0·219 ± 0·006, 8·35 ± 0·10, 1·25 ± 0·20 barns respectively. W. J. SWIATECKI

539.172.4

8207. Total cross-sections of the elements for 156 MeV neutrons. A. E. TAYLOR, T. G. PICKAVANCE, J. M. CASSELS AND T. C. RANDLE. *Phil. Mag.*, **42,** 751–5 (*July*, 1951).

Measurements have been made of the total cross-sections of 10 elements for neutrons of effective energy 156 ± 3 MeV. The results are discussed in the light of the theory of Fernbach, Serber and Taylor [Abstr. 5006 (1949), 3038 (1951)]. A.

539.172.4

8208. Thermal neutron capture cross sections. H. POMERANCE. *Phys. Rev.*, **186,** 641–5 (*Aug.* 1, 1951)

The Oak Ridge pile oscillator has been used for a

survey of the thermal neutron capture cross-sections of the elements. Sixty-nine elements from atomic number 3 to 82 have been measured by comparison with Au whose capture cross-section is known from other experiments. From the internal consistency of the measurements, the care in selecting samples, and the accuracy of the value for Au, these values are estimated to be accurate within 5%. A comparison is made with the results of other pile oscillator measurements and of other methods such as time-of-flight and activation. A.

539.172.4

8209. Correlation phenomena and capture of polarized neutrons. O. HALPERN. Letter in *Phys. Rev.*, **83**, 669 (*Aug.* 1, 1951).

If a cascade follows absorption of a polarized neutron, the angular correlation phenomena are significantly affected—e.g. the interference terms in the correlation expression [Abstr. 3719 (1951)] vanish only in special cases even if angular momentum is quantized along the direction of an outgoing particle. R. H. DALITZ

539.172.4 : 539.166

Neutron capture γ-rays from F, Na, Mg, Al and Si. *See Abstr.* 8177

539.172.4

8210. The total charges of fission fragments in gaseous and solid stopping media. N. O. LASSEN. *K. Danske Vidensk. Selsk. Mat.-fys. Medd.*, **26** (*No.* 5) 28 *pp.* (1951).

The charges in gases are functions of the gas pressure as a result of a competition between radiation and loss of electrons from excited states in the fragment ions. At low pressures the charges are much smaller than the charges in solid materials, from which an estimate can be obtained of the order of magnitude of the cross-section for electron capture by the fragments in gases. In gases the light fragment has a higher charge than the heavy fragment, as opposed to what is the case in solids, removing in this respect the discrepancy between the effective and the total charges. J. HUGHES

539.172.4

8211. Measurement of the temperature of the neutrons in the reflector of a heavy water pile. A. ERTAUD AND R. BEAUGÉ. *J. Phys. Radium*, **12**, 580–4 (*May*, 1951) *In French.*

This was done (at Châtillon) by measuring the transmission through a layer of absorbers and asuming a Maxwellian neutron spectrum. Results (580–380°K) are given for different positions in the reflector and at the mouth of a channel in the concrete shield. W. J. SWIATECKI

539.172.4

8212. Calculation of the critical state of a cylindrical pile provided with a reflector. J. YVON. *J. Phys. Radium*, **12**, 573–9 (*May*, 1951) *In French.*

The Laplacian of an atomic pile consisting of a cylinder of active material embedded up to one of its faces in a mass of graphite is evaluated by a perturbation procedure taking advantage of the Hermiticity of the operators in the diffusion equation. The case when a thin sheet of absorber is interposed between the cylinder and the graphite is also treated. W. J. SWIATECKI

539.172.4

8213. Chalk River N.R.X. nuclear reactor. D. G. HURST. *Elect. Engng, N.Y.*, **70**, 476–8 (*July*, 1951).

A short elementary survey of the Canadian heavy water-natural uranium reactor. L. R. SHEPHERD

539.172.4

8214. Nuclear data for low power research reactors. *Canad. J. Phys.*, **29**, 203–4 (*March*, 1951).

For abstract see Abstr. 4745 (1951).

539.172.4

8215. BEPO: British experimental pile. *Nucleonics*, **8**, 36–7 (*June*, 1951).

A short account of recently released information on the graphite-moderated natural uranium air-cooled pile at Harwell. See Abstr. 6470 (1951). L. R. SHEPHERD

539.172.4

8216. Industrial utilisation of fission products. *Nucleonics*, **8**, 5–11 (*May*, 1951).

Fission products might be utilized in the crude form with β and γ activities $\sim 1\,000$ curies/lb or as separated isotopes with activities up to 30 000 c/lb. Possible uses include destruction of bacteria in foodstuffs, sterilization of larger organisms, initiation and stimulation of certain chemical reactions, elimination of static electricity and provision of permanent ionization in discharge tubes. Costs of fission products in gross or separated forms are estimated and a list of fission products with half-life > 40 days, yield $> 0{\cdot}5\%$ and radiation energy $> 0{\cdot}1$ MeV is given. L. R. SHEPHERD

539.172.4

8217. An enriched homogeneous nuclear reactor. *Rev. Sci. Instrum.*, **22**, 489–99 (*July*, 1951).

A discussion is given of the design considerations, operational procedures, safety devices and performance of a small homogeneous reactor using enriched uranium in a water solution and beryllium oxide and graphite for the neutron reflector. A high-power and a low-power phase of this reactor are described. A.

539.174

8218. Nuclear excitation by electric interaction with charged particles. R. HUBY AND H. C. NEWNS. *Proc. Phys. Soc., Lond. A*, **64**, 619–32 (*July*, 1951).

Inelastic scattering of charged particles can take place through the electrostatic interaction between the particles and the nucleus. Expressions for the total cross-section of the process have been derived using several methods and are found to be in close agreement. The angular distributions are less reliable. Questions for more practical interest are discussed and conditions given for the best observation of the effect. The total cross-sections are not negligible and certain experimental results can be explained. Inelastic nuclear scattering has been extensively used hitherto to obtain the positions of nuclear energy levels. It is suggested that more information about nuclear states might be provided by experiments exploiting the electrostatic interaction. A.

ATOM AND MOLECULE BEAMS . MESONS. NEUTRONS 539.18

539.18

8219. On the absorption of negative π-meson by proton. II. E. YAMADA, Y. NAGAHARA AND S. OGAWA. Letter in *Progr. Theor. Phys.*, **6**, 131–2 (*Jan.–Feb.*, 1951).

For Pt I, see Abstr. 5724 (1951). The cases considered are those when the emitted π^0 is scalar but the π^- may be scalar or ps.-scalar, vector or ps.-vector with various types of coupling. The π^0 to nucleon coupling constants necessary to ensure agreement with experimental results [Abstr. 1300 (1951)] are tabulated.

W. J. SWIATECKI

539.18

8220. On the production of π^+ mesons in carbon. E. M. HENLEY AND R. H. HUDDLESTONE. Letter in *Phys. Rev.*, **82**, 754 (*June* 1, 1951).

The meson spectrum is calculated using the phenomenological analysis of meson production in free nucleon-nucleon collisions [Abstr. 6748 (1951)].

W. J. SWIATECKI

539.18

8221. Inelastic scattering of π-mesons. M. H. JOHNSON. *Phys. Rev.*, **83**, 510–12 (*Aug.* 1, 1951).

The inelastic scattering of a π-meson is considered as the result of an elastic collision between a meson and a free nucleon. The nuclear model determines the initial nucleon momentum distribution and limits the possible final states. The energy and angular distribution of scattered mesons is obtained in terms of the scattering probability in relative co-ordinates which depends only on the momenta of the meson relative to the struck nucleon. Energy distributions of the scattered mesons, calculated for several cases from the differential cross-section, indicate that collisions in which the meson loses most of its kinetic energy are relatively infrequent. A.

539.18

8222. The capture and decay of mesons in photographic emulsions. W. F. FRY. *Phys. Rev.*, **81**, 594–7 (*Aug.* 1, 1951).

Meson events have been studied in Eastman NTB-3 plates which were exposed to cosmic radiation in the stratosphere by means of balloons. It is found that $68 \pm 7\%$ of the mesons ending in the emulsion which do not produce stars or without associated secondary mesons decay with the emission of a high-energy electron. Of these mesons, $11{\cdot}6 \pm 1{\cdot}5\%$ (presumably $23{\cdot}2\%$ of the negative mesons) have associated electrons with energies in the interval from 15 to 70 keV. The energy distribution of these electrons is well represented by a simple exponential with a mean energy of 17 keV. Electrons with energies in the interval from 15 to 70 keV are observed from $19{\cdot}6 \pm 4{\cdot}0\%$ of the stars caused by negative π-mesons. A.

539.18

8223. The spin of the pion via the reaction $\pi^+ + d \rightleftharpoons p + p$. R. DURBIN, H. LOAR AND J. STEINBERGER. *Phys. Rev.*, **83**, 646–8 (*Aug.* 1, 1951).

It is possible to determine the spin of the pion by comparing the forward and backward rates of the reaction $\pi^+ + d \rightleftharpoons p + p$. The backward rate has been measured in Berkeley. The authors measured the forward rate. Comparison of the two results shows the spin to be zero. In the light of other recent experimental results the meson is then pseudoscalar. A.

539.18

8224. Cross section for the reaction $\pi^+ + d \rightarrow p + p$ and the spin of the π^+ meson. D. L. CLARK, A. ROBERTS AND R. WILSON. Letter in *Phys. Rev.*, **83**, 649 (*Aug.* 1, 1951).

The total absorption cross-section for 22·7 MeV π^+ mesons in deuterium has been measured ($\sim 4{\cdot}5$ mb). Comparison with the inverse process, π^+ meson production by 340 MeV protons incident on protons at rest, shows, from detailed balancing, that the spin of the π^+ meson is zero. The existence of the process $\pi^- + d \rightarrow n + n$ then implies further that charged π-mesons are pseudoscalar. R. H. DALITZ

539.18

8225. π^- meson reactions in tritium. A. M. L. MESSIAH, E. R. CAIANIELLO AND S. BASRI. Letter in *Phys. Rev.*, **83**, 652 (*Aug.* 1, 1951).

For the reaction $\pi^- + H^3 \rightarrow 3n$, angular momentum and parity conservation provide no selection rules, but if H^3 ground state is mainly space-symmetric and has isotopic spin $\frac{1}{2}$, the reaction is practically forbidden for scalar or pseudovector meson (captured from K orbit). Hence the ratio of non-radiative to radiative capture by H^3 is much greater for an odd meson than for an even meson. R. H. DALITZ

539.18

8226. Electromagnetic interactions of μ-mesons. W. D. WALKER, J. E. HAMMEL, R. M. SINCLAIR AND J. D. SORREL. Letter in *Phys. Rev.*, **83**, 655 (*Aug.* 1, 1951).

Knock-on electrons produced by mesons with range between 35 and 37 in Pb were studied in a cloud chamber containing 6 C and 1 Pb plates. The results agree with calculation up to momentum transfers of 25 MeV/c, indicating the validity of the inverse square law down to $4 \cdot 10^{-12}$ cm. E. P. GEORGE

539.18

8227. Capture of μ-mesons in heavy elements. F. B. HARRISON, J. W. KEUFFEL AND G. T. REYNOLDS. Letter in *Phys. Rev.*, **83**, 680 (*Aug.* 1, 1951).

Using large liquid scintillation counters, mean-life measurements have been extended to Cu ($0{\cdot}122 \pm 0{\cdot}014$ μsec) and Sb ($0{\cdot}050 \pm 0{\cdot}006$ μsec).

E. P. GEORGE

539.18

8228. The ionisation loss of μ-mesons at relativistic energies in anthracene. T. BOWEN AND F. X. ROSER. Letter in *Phys. Rev.*, **83**, 689 (*Aug.* 1, 1951).

This was found not to vary between 325 and 2 700 MeV, consistent with calculations based on the density effect. E. P. GEORGE

539.18

8229. Meson scattering. H. A. BETHE AND R. R. WILSON. Letter in *Phys. Rev.*, **83**, 690 (*Aug.* 1, 1951).

By comparison of meson scattering data at Cornell with the theory of diffraction scattering, the index of refraction of the nucleus for mesons is obtained, whence the cross-section for meson scattering by a

single nucleon is deduced, in order-of-magnitude agreement with perturbation calculations in pseudoscalar meson theory. The discrepant results of some other experimenters, and their implications, are discussed. R. H. DALITZ

539.18

8230. On the spin of the μ-meson. E. R. CAIANIELLO. *Phys. Rev.*, **83**, 735–40 (*Aug.* 15, 1951).

The behaviour of a μ-meson of spin $\frac{3}{2}$ is investigated for the processes $\mu \rightarrow e + 2\nu$, $\pi \rightarrow \mu + \nu$, $\mu^- + \text{"}p\text{"} \rightarrow \text{"}n\text{"} + \nu$. These processes have been chosen because they give direct information on the nature of the μ-meson and do not require second quantization of the μ-meson field, which is not feasible for spin values greater than 1 when electromagnetic interactions are present. The theory used to describe the μ-meson is due to Rarita and Schwinger. The spectra for the $\mu \rightarrow e + 2\nu$ decay are obtained for the same modes of decay considered by Tiomno and Wheeler for μ-mesons of spin $\frac{1}{2}$. Their most relevant feature is that none of them goes to zero at maximum electron energy. It is to be hoped that more careful measurements of this spectrum will permit a decision on the spin value of the μ-meson. The μ-capture is studied by assuming the process to happen via an intermediate scalar or pseudoscalar π-meson. Comparison with the lifetime for $\pi \rightarrow \mu$-decay and use of experimental data allow an evaluation of the constant coupling the π-meson to nucleons. The plausibility of this value is taken as a test for the plausibility of the assumed spin value of the μ-meson. The results do not appear to contradict present-day evidence, due to the uncertainty of the nuclear matrix elements. The formulae obtained apply, of course, to any spin $\frac{3}{2}$ particle undergoing similar processes. A.

539.18 : 539.172.3

Production of mesons by photons. *See Abstr.* 8198–201

539.185

8231. Slow-neutron detection by foils. I. C. W. TITTLE. *Nucleonics*, **8**, 5–9 (*June*, 1951).

Outlines the activation method of measuring slow neutron flux, particularly the use of In foils. The separation of the effects of thermal, resonance and fast neutrons is discussed. L. R. SHEPHERD

539.185

8232. A method of calibrating neutron sources absolutely. D. J. LITTLER. *Proc. Phys. Soc., Lond. A*, **64**, 638–47 (*July*, 1951).

A method has been developed for calibrating neutron sources absolutely, using the Graphite Low Energy Experimental Pile. The method used is to convert the measurement of the number of neutrons emitted by a source to a determination of the absolute beta activity of an irradiated Na or P sample. One source calibrated by this method, which contained 1 290 mg of Ra in the form of sulphate, mixed with 12 g of Be, was found to have a neutron strength of $9{\cdot}3 \times 10^6$ n/sec (± 4½%). A.

539.185

8233. Fast neutron energies determined by the use of resonant scatterers. P. H. STELSON AND W. M. PRESTON. Letter in *Phys. Rev.*, **83**, 469 (*July* 15, 1951).

Describes a method of measuring fast neutron energies by measuring the scattering by an element whose cross-section is a known function of neutron energy. Applications are given. J. THEWLIS

539.185

8234. The scattering phase shifts of two-nucleon systems. S. A. KUSHNERIUK AND M. A. PRESTON. *Proc. Phys. Soc., Lond. A*, **64**, 712–25 (*Aug.*, 1951).

Energy expansions for simple functions of the scattering phase shifts are given for all relative angular momenta for central forces in neutron-proton and proton-proton scattering and for non-central static forces in proton-proton scattering, including the coupling of P and F states. The differential scattering cross-section for this latter case is given in an appendix. A.

539.185

8235. Neutron-proton scattering in the energy range of 18 to 21 MeV. E. M. BALDWIN. *Phys. Rev.*, **83**, 495–9 (*Aug.* 1, 1951).

The relative cross-sections for neutron-proton scattering in the neutron energy range of 18 to 21 MeV were measured by means of a proportional counter telescope at the laboratory proton recoil angles of 15 degrees and 33 degrees 24 minutes, respectively. From these data a ratio of $1{\cdot}06 \pm 0{\cdot}16$ for neutrons scattered in the centre-of-mass system in the backward direction to those scattered in the sideways direction was computed. A.

539.185

8236. Neutron-deuteron scattering amplitudes. E. O. WOLLAN, C. G. SHULL AND W. C. KOEHLER. *Phys. Rev.*, **83**, 700–2 (*Aug.* 15, 1951).

The diffraction of neutrons from deuterium-containing compounds gives the coherent scattering section of D which can be used to determine the spin-dependent scattering amplitudes. Studies have been made on a number of D-containing compounds, but the results reported here are concerned primarily with recent measurements on NaD. X-ray measurements have been used in interpreting the thermal vibration effects in the crystal and use has been made of Na scattering cross-section data obtained from various Na-containing compounds. This experiment gives $\sigma_{coh} = 5{\cdot}2 \pm 0{\cdot}3$ barns. This value can be combined with the results of other D cross-section measurements to give pairs of values for the individual quartet and doublet spin amplitudes for n–d scattering. Various experimental results bearing on this point are summarized. Recent theoretical work seems to have eliminated the ambiguity in the experiments with regard to which of two sets of values of the spin amplitudes is to be chosen. A.

539.185 : 539.172.4

8237. The energy dependence of the resonant scattering of slow neutrons from gold. J. TITTMAN AND C. SHEER. *Phys. Rev.*, **83**, 746–56 (*Aug.* 15, 1951).

The energy-dependence of slow neutrons scattered from a thick Au target has been measured using a newly developed scattering chamber in conjunction with the Columbia slow neutron velocity spectrometer. A method of analysis has been developed for determining the ratio of the scattering cross-section to the total cross-section, σ_s/σ_t, as a function of

energy for an "unknown" sample in terms of a calibration target for which $(\sigma_s/\sigma_t)(E)$ is known. The agreement between the experimental determination of $(\sigma_s/\sigma_t)(E)$ for Au in the energy range 0·7 to 8 eV and the Breit–Wigner theory is excellent. All the level parameters can be evaluated by combining these scattering data with the results of transmission experiments and the cross-section for self-indication. The final results for the 4·9 eV gold level are: $J = 1$, $\Gamma = 0{\cdot}172$ eV, $\Gamma_N = 0{\cdot}0211$ eV, $R_{J=1} = 1{\cdot}03$ barn$^{\frac{1}{2}}$, $R_{J=2} = 0{\cdot}917$ barn$^{\frac{1}{2}}$. A.

STRUCTURE OF SOLIDS 539.2

539.21 : 541.64

8238. Calculation of degree of crystallinity in polymers from density measurements. F. P. PRICE. Letter in *J. Chem. Phys.*, **19**, 973 (*July*, 1951).

This is calculated from the change in specific volume with temperature, using:

$$X = (V_{lg} - V)/(V_{lg} - V_s)$$

in which V is specific volume of mixture, V_s specific volume of crystals and V_{lg} specific volume of liquid or glass. The result agrees with that of the calorimetric method for polyethylene, and limits of crystallinity are obtained for polychlorotrifluoroethylene.

C. TURNER

539.213

8239. The amorphous state. J. A. PRINS. Note in *Z. Naturforsch.*, **6a**, 276–7 (*May*, 1951) *In German.*

A truly disordered state shows a "gas" interference pattern, statistical short-range order shows a "liquid" pattern, but colloidal crystallites, in close packing, give a primary ray, much less broadened than the interference lines. There are 3 differences from the liquid diffraction pattern: (1) non-reproducible intensities; (2) interference bands in the same places as the lines from the crystal powder; (3) gradual change to normal crystalline pattern can occur. Layers formed by evaporation *in vacuo* are often colloidal-crystalline because of inclusions. The distribution function of the intermolecular distances cannot be found from the liquid pattern. In calculating the outer small-angle scattering of heavy atoms total reflection and refraction have to be taken into account. C. TURNER

539.215.7

8240. New segregation phenomena in metals. M. T. STEWART, R. THOMAS, K. WAUCHOPE, W. C. WINEGARD AND B. CHALMERS. Letter in *Phys. Rev.*, **83**, 657 (*Aug.* 1, 1951).

Lead-bismuth alloys containing radioactive Bi were examined by autoradiography for segregation of the Po resulting from the decay of the Bi. Segregation was observed along crystal boundaries and at the surface. A periodic distribution, related to variations in the speed of solidification, was observed for crystals allowed to solidify under conditions of linear growth.

539.217

8241. Coefficients of thermal diffusion of P^{32} and of S^{35} in sodium chloride. M. CHEMLA. *C.R. Acad. Sci., Paris*, **232**, 2424–6 (*June* 25, 1951) *In French.*

Previously [see Abstr. 6490 (1951)] it has been shown that P^{32} and S^{35}, produced by rapid neutrons in a monocrystal of sodium chloride, diffuse towards the surface at temperatures about 650°. The coefficients of diffusion (D) are now shown to vary with temperature according to $D = D_0 e^{-(W/kT)}$. The energies of activation (W) are shown to be 1·90 eV for S^{35} and 3·30 eV for P^{32}. The displacements of these ions are effected by means of the negative reticular spaces in the crystal. H. H. HODGSON

539.217

8242. Anelastic measurements of diffusion coefficients in f.c.c. substitutional solid solutions. A. D. LE CLAIRE. *Phil. Mag.*, **42**, 673–88 (*July*, 1951).

It is shown how in face-centred cubic substitutional solid solutions of metals, measurements upon that form of anelasticity which is associated with the preferential reorientation of pairs of solute atoms in the presence of a tensile stress, may be used to obtain the diffusion coefficient of the solute atoms. The method is closely analogous to the one employed recently by Zener and by Wert to measure diffusion coefficients in interstitial solid solutions. The theory is applied to some previously reported anelastic measurements on (70/30) α-brass by Zener and by Kê to give the diffusion coefficient of Zn in the brass. The results show good agreement with directly measured and suitably corrected diffusion coefficients when these are extrapolated to the lower temperatures at which the anelastic measurements were made. A.

539.217 : 539.16

8243. Radioactive tracers in solid solution investigations. W. T. FOLEY AND P. A. GIGUERE. *Science*, **113**, 754–5 (*June* 29, 1951).

The use of radioactive tracers for ascertaining whether or not a compound forms solid solutions with another compound is described. When applied to the system H_2O–H_2O_2 (with P^{32} in the form of KH_2PO_4 as tracer) the method yielded the following results: when freezing both the diluted (10%) and concentrated (90%) aqueous solution of H_2O_2 one obtained a solid phase which was pure ice and pure solid H_2O_2, respectively. F. LACHMAN

539.217.5

8244. The calculation of diffusion coefficients from sorption data. S. PRAGER. *J. Chem. Phys.*, **19**, 537–41 (*May*, 1951).

A method is described for the calculation of the dependence of the diffusion coefficient on the concentration of diffusing material from data obtained by studying the rates of sorption of vapours by films. The principle of the method is to approximate the actual concentration-dependence by a step function. For such a function the differential equations involved can be solved analytically, and the heights of the individual steps can be computed; the step function is then smoothed out by an averaging process. The method has been tried out for the sorption of isobutane by polyisobutylene at 35°c and found to be quite satisfactory. A.

539.219

8245. Physico-chemical phenomena in the ceramic industry. R. LECUIR. *Ann. Radioélectricité*, **6**, 20–50 (*Jan.*, 1951) *In French.*

The formation and the ceramic sintering of oxides free from the characteristic plasticity of clays are described. These results are attained through various organic additions according to the moulding, spinning and turning technique used. The processes dealt with allow sintering of an oxide to occur by which the mechanism may be studied under conditions involving a lower number of variables than in classical ceramics. Conditions are described under which a tight sintered product may be obtained by recrystallization in a wide temperature field; the smaller the crystallite of initial powder, the greater the contraction and the lower the required temperature. The more important contacts established between the surfaces of specks through high pressure reduce the contraction and lower the sintering temperature.

H. H. HODGSON

539.22

8246. Precipitation of carbon and nitrogen in cold worked alpha-iron. S. HARPER. *Phys. Rev.*, **83**, 709–12 (*Aug.* 15, 1951).

The strain-induced precipitation of carbon and nitrogen from supersaturated solution in alpha-iron is shown to be in agreement with a dislocation mechanism, and estimates of the dislocation density required to produce the observed precipitation rates are in agreement with dislocation theory. The activation energies involved in the process are found to be 20 000 cal/mole for carbon and 17 200 for nitrogen, in agreement with published data for the activation energies of diffusion of the two solutes. A.

539.234

8247. Evaporation in vacuum by direct bombardment from an electron gun. J. BROCHARD, P. GIACOMO, P. JACQUINOT AND S. ROIZEN. Letter in *J. Phys. Radium*, **12**, 632 (*May*, 1951) *In French.*

To prevent the molten material from attacking the support, heating was carried out by means of a 2–5 kV, 10–50 mA electron gun of the type used in X-ray tubes. A. H. W. BECK

539.234

8248. Preparation of Ag–Mg alloys in thin layers by the simultaneous evaporation of the constituents in vacuum. S. GOLDSZTAUB AND P. MICHEL. *C.R. Acad. Sci., Paris*, **232**, 1843–5 (*May* 16, 1951).

Varying amounts of Ag and Mg were simultaneously evaporated in vacuum on to collodion films and studied by electron diffraction. All phases, with the exception of the γ phase, already known to exist from X-ray investigations, were detected and the β phase was found to occur spontaneously in an ordered structure. Tables are provided giving the reflections obtained and the corresponding lattice spacings. H. P. MYERS

539.26

8249. X-ray investigation of the transformations in a surface layer of a metal under the action of electric discharges. L. S. PALATNIK. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **15** (*No.* 1) 80–6 (1951) *In Russian.*

The investigations are of a great importance for the contact phenomena in electric machines and circuits, commutation, where the effects are of an adverse character, but also for the new techniques of spark hardening and machining of metals, where the effects are desirable. There are two stages of the effects of electric discharges on steel electrodes, related by characteristic phenomena, viz. the 1st stage is that of a selective interaction (cementation) in the liquid phase of the metal with the surrounding medium and the opposite electrode, and the 2nd stage, of the formation of metastable structures emerging from the affected micro-domain of the metal electrode under a spot-hardening effect. The material investigated was mainly Armco-iron, under spark discharges in atmospheres of transformer oil, aniline and air. Much experimental data was collected and the investigations included microanalysis of etched cuts, electrolytic phase separation and electron-microscopical investigations. The energy liberated by a spark was found sufficient to melt a volume of about 10^{-2} cm^3 of the specimen, which re-solidifies within about 10^{-3} sec. B. F. KRAUS

539.26

8250. An X-ray technique for the study of substructures in materials. P. GAY AND P. B. HIRSCH. Note in *Acta Cryst.*, **4**, 284–5 (*May*, 1951).

In back-reflection X-ray photographs from polycrystalline metallic materials taken with a sufficiently narrow X-ray beam, individual reflections may be distinguished and from the positions and nature of the spots and arcs the size and orientation of the particles may be determined. The method can detect grain boundaries and mosaic structures not revealed by standard metallurgical methods. A. E. DE BARR

539.266

8251. Diffraction of X-rays by benzene and variation with temperature. F. CENNAMO. *Atti. Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **10**, 475–8 (*June*, 1951) *In Italian.*

Using the same source of X-rays as in a previous paper [Abstr. 4786 (1951)] the diffraction by C_6H_6 enclosed in a mica cell heated by a water jacket has been examined at temperatures 15–66°C. Diffraction curves obtained by the photographic method are compared with the theoretical curve of Raman and the experimental results of Hewlett obtained by the ionization method. T. A. CHALMERS

539.27

8252. Thin films produced by electronic and ionic bombardment of hydrocarbons. H. KÖNIG AND G. HELWIG. *Z. Phys.*, **129** (*No.* 5) 491–503 (1951) *In German.*

A simple glow discharge apparatus is described for producing, in an atmosphere of benzol vapour, thin films of a hydrocarbon polymer identical with that described by Harkins. The properties of these films are studied by depositing them on a quartz plate. They offer many possibilities for use in electron diffraction and microscopy, especially in studying transformations at high temperatures and in forming carbon replicas of biological objects such as diatoms and algae, stereoscopic examination of which throws much light on their structure.

H. J. H. STARKS

539.27 : 537.533.92 : 548.7

8253. Study of ionic crystals under electron bombardment. D. E. McLennan. *Canad. J. Phys.*, **29**, 122–8 (*March*, 1951).

Electron bombardment experiments have been carried out on small crystals of the alkali halides within the electron microscope. Crystals of two size ranges were bombarded at high intensity, and evidence of a generalized photographic effect within the ionic group of solids is presented. The first group of crystal specimens ranged in size from 0·2 to 0·002 cm, the bombardment causing the formation of F-centres and entrapped metal colloids in the crystal lattice. Ionization pulses were observed to occur in the region of the specimen during bombardment. The second group ranged in size from 10 to 0·01 μ, observations on the effects of bombardment being carried out with electron diffraction techniques. A process has been suggested to explain the phenomenon of ionic crystals which appear to lose their centres under high electron beam intensity in the electron microscope. A.

539.27

8254. The morphology of zinc oxide smoke particles. J. M. Cowley, A. L. G. Rees and J. A. Spink. *Proc. Phys. Soc., Lond. B*, **64**, 638–44 (*Aug.*, 1951).

Single-crystal electron diffraction patterns with doubled spots obtained from ZnO smoke particles originate from pairs of thin sheets which are commonly seen in electron micrographs of this material joining up the members of a group of four spines. The plane of each sheet is parallel to a $(1\,0\bar{1}0)$-type lattice plane. The sheets are continuous with one of the spines and spaced at 120° intervals around this spine. The other three spines, and additional spines which grow from corners of the sheets, are related to this one spine and the sheets by twinning on $(1\,1\bar{2}2)$ planes. Intensity measurements of single-crystal patterns allow the shape-transform and thickness of the sheets to be deduced. Sharp lines and extra spots indicate the occasional presence of lattice imperfections in the form of parallel faults. Electron micrographs show wide deviations from the idealized group of spines and sheets. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

8255. Defects of accepted elasticity theory. O. Föppl. *Schweiz. Arch. angew. Wiss. Tech.*, **17**, 171–7 (*June*, 1951) *In German.*

The fundamental assumptions made in the 3 different strain-stress relationships of elastic theory are discussed with the aid of simple examples.

H. J. H. STARKS

539.31

8256. Elastic energy of an ellipsoidal inclusion in an infinite solid. K. Robinson. *J. Appl. Phys.*, **22**, 1045–54 (*Aug.*, 1951).

An exact solution in closed form is presented for the displacements, stresses and total elastic energy for the problem of an ellipsoidal isotropic inclusion bonded to an isotropic body of infinite extent when the inclusion and the infinite solid have uniformly distributed changes in their stress-free specific volumes. The physically important details of the dependence of the total strain energy of the two materials upon the shape and volume of the inclusion, the elastic moduli of the two isotropic materials and the changes of specific volume, are included. The solution is indicated for the stresses and displacements for the case where the material at infinity is, in addition to the above condition, in a homogeneous state of stress whose principal directions are parallel to the axes of the cavity. A.

539.319

8257. Use of the piezoelectric gauge for internal friction measurements. J. Marx. *Rev. Sci. Instrum.*, **22**, 503–9 (*July*, 1951).

The addition of an auxiliary quartz crystal to the usual composite piezoelectric resonator provides a convenient strain gauge, which simplifies the measurement procedure and permits the evaluation of amplitude-dependent decrements over a wide range of strain amplitudes. Virtually instantaneous values of the decrement are obtained, thus bringing transient internal friction phenomena under observation. Mechanical resonance frequencies may be precisely determined for high as well as low decrement specimens. The numerical evaluation of terms is carried out for a recommended driver-gauge construction of 18·5° X-cut quartz bars. A.

539.32

8258. On the elastic properties of sodium chloride. J. Chatelet and R. Cabarat. *C.R. Acad. Sci., Paris*, **232**, 2111–12 (*June* 4, 1951) *In French.*

Measurements of Young's modulus and the internal friction (f) by acoustic methods. Results are briefly stated: effects of annealing; the influence of the surface state on f; f's independence of orientation.

A. J. KENNEDY

539.32

8259. Elastic constants of galena. S. Bhagavantam and T. Seshagiri Rao. Letter in *Nature, Lond.*, **168**, 42 (*July* 7, 1951).

New measurements give: $c_{11} = 12{\cdot}70$, $c_{12} = 2{\cdot}98$, $c_{44} = 2{\cdot}48$ and $K = 6{\cdot}22$, $\times 10^{11}$ dyne cm^{-2}. See Abstr. 2043 (1950). A. R. STOKES

539.32

8260. A remark on the composition dependence of the elastic parameters of beta-brass. J. S. Rinehart. Letter in *J. Appl. Phys.*, **22**, 1089 (*Aug.*, 1951).

539.32 : 535.417

8261. The measurement of the Young's modulus of metals and alloys by an interferometric method. I. The Young's modulus of Ni–Cu alloys. T. Fukuroi and Y. Shibuya. *Sci. Rep. Res. Inst. Tôhoku Univ. A*, **2**, 748–57 (*Oct.*, 1950).

A description is given of the bending apparatus making use of an interferometric method, and the device for eliminating perfectly the disturbing mechanical vibrations. The experimental results obtained by this statical method on the Young's modulus of Ni–Cu alloys proved to agree qualitatively with Yamamoto's results which were obtained by the dynamical method. A.

539.32 : 541.182.5

8262. Determination of elastic constants of gels by ultrasonic method. A. M. SRIVASTAVA. *Proc. Nat. Acad. Sci. India*, **18** (*No.* 2) 51–64 (1949).

The ultrasonic pulse technique developed herein is applied to the determination of the elastic moduli of 4 gels. The method is entirely new to this type of work and recommends itself because the determinations are quick, accurate and the sample is left undamaged after experimentation. The theories of gel formation have been analysed in brief and attempts are being made to correlate them with the elastic data obtained. A.

539.32 : 541.182.5

8263. Ultrasonic studies of gels. A. M. SRIVASTAVA. *Indian J. Phys.*, **25**, 17–20 (*Jan.*, 1951).

Using an ultrasonic pulse technique the elasticities of gels have been obtained at 4 ultrasonic frequencies. The effect of temperature and age on the iron silicate gels has been studied. A brief discussion outlines the probable structure and mechanism of gel formation, maintaining that the ultimate units in a gel are groups of atoms producing an interlinked fibrous structure perfectly randomly oriented. A.

539.374

8264. Some extensions of elementary plasticity theory. F. EDELMAN AND D. C. DRUCKER. *J. Franklin Inst.*, **251**, 581–606 (*June*, 1951).

A detailed investigation is presented of yield or loading criteria, for work hardening materials, which lead to constant strain ratios under increasing stress when stress ratios are maintained constant. The experimenter is given a choice of incremental stress-strain theories with which results of simple or complicated combined loading tests may be correlated. These theories are dealt with in order of increasing complexity and, at the same time, increasing capacity to represent experimentally established phenomena. The objective is the use of the mathematically simplest theory which will provide the desired flexibility in the analysis of experimental data. Loading functions of isotropic as well as anisotropic types are examined, among them those depending explicitly on stress alone and those depending on both stress and plastic strain. In the latter cases only those functions are investigated in which plastic strain appears to the first order. The predicted results of some basic tests are examined for several loading criteria. A.

539.374

8265. On combined bending and twisting of thin tubes in the plastic range. R. HILL AND M. P. L. SIEBEL. *Phil. Mag.*, **42**, 722–33 (*July*, 1951).

Equations for the determination of the stresses and warping in a partly plastic thin tube of arbitrary section are obtained for any monotonic loading by bending and twisting couples. The analysis is based on the von Mises yield criterion and the Reuss stress-strain relations. The equations are solved numerically for a circular tube for various loading programmes. A.

539.374

8266. Relation between the heterogeneity of plastic deformation of iron and the critical amount of cold working. Application to the preparation of single crystals. M. MOUFLARD AND P. LACOMBE. *C.R. Acad. Sci., Paris*, **233**, 174–6 (*July* 9, 1951) *In French.*

See also Abstr. 3096 (1951). The elastic properties of both cast and fritted metals depend on their previous mechanical history. In some cases the electrical resistance decreases with temp., and during cooling the resistance at a given temp. < that at the same temp. during heating. X-rays of one sample show only the monoclinic form (Baddeleyite). The mechanical treatment required to give a single crystal 15×2 cm, 0·5 mm thick, is described. N. CORCORAN

539.374

8267. On the state of stress in a plastic-rigid body at the yield point. R. HILL. *Phil. Mag.*, **42**, 868–75 (*Aug.*, 1951).

The yield point of a plastic-rigid body is defined as the moment when deformation first becomes possible as the load is increased. The practical significance of the yield-point load for an actual plastic-elastic body is discussed. It is then shown that part of the plastic zone at the yield point, namely the part where deformation occurs, depends only on the current surface tractions and not on the previous loading programme. By means of the principle of maximum plastic work and its complementary minimum principle (Hill, 1950) approximations from above and below to the yield-point load can be obtained; some examples are given. Recent American work on the plastic limit design of structures is critically reviewed and shown, when properly regarded, to be a particular application of the principle of maximum plastic work. A.

539.374

8268. A theoretical investigation of the compression of a ductile material between smooth flat dies. A. P. GREEN. *Phil. Mag.*, **42**, 900–18 (*Aug.*, 1951).

The theory is 2-dimensional and an ideal plastic-rigid material is assumed. Slip-line fields are proposed for all ratios of width of dies to height of block greater than 1. It is found that the velocity field transforms into its corresponding slip-line field. Other plane plastic problems where this correspondence occurs are cited. Since the velocities are known along only one slip-line boundary, the usual numerical procedure for calculating the field has to be modified and the use of influence coefficients is introduced. Solutions are computed for width/height ratios between 1 and 2, and it is observed that simple analytical relations hold between these ratios and the corresponding velocity discontinuities in the field. The calculated mean pressures on the dies are compared with upper and lower bound curves derived by Hill on the basis of extremum principles. The deformation after different finite indentations is illustrated by photographs of experiments using (*a*) plasticine models, and (*b*) Al alloy strip. Similar fields are proposed for extrusion or drawing through a wedge-shaped die with large reductions, but no solutions have been computed. A.

539.378.6

8269. The effect of grinding on particles. B. C. BRADSHAW. *J. Chem. Phys.*, **19**, 1057–9 (*Aug.*, 1951).

Although much experimental work has been done

on grinding, many well-known facts concerning this process and its effect on particles remain unexplained. The writer postulates that the well-known limiting distribution of particle sizes, which results from long continued grinding, is dynamic rather than static. A.

539.385

8270. The axis of distortion of a twisted elastic prism. D. G. ASHWELL. *Phil. Mag.*, **42**, 820–32 (*Aug.*, 1951).

Duncan, Ellis and Scruton have shown (1933) that if an elastic cantilever is twisted, the displacement of its tip relative to its support consists of a rotation about the flexural centre of its cross-section. In this paper is considered the distortion of a twisted prism without reference to its support, and it is found that the axis of distortion of such a prism is in general quite different from the axis of displacement found by Duncan, Ellis and Scruton. General expressions are derived for the determination of the axis of distortion, and its effect on practical cantilevers subjected to finite twisting is estimated. Experiments designed to test the analysis are described, and their results are found to confirm it satisfactorily. A.

539.389.3 : 539.26

8271. A study of fatigue in metals by means of X-ray strain measurement. J. A. BENNETT. *J. Res. Nat. Bur. Stand.*, **46**, 457–61 (*June*, 1951).

X-ray determinations of lattice strain were made on steel specimens under a series of static bending moments. These series of determinations were made on the specimens as normalized and after various amounts of fatigue stressing. The slope of the line relating the bending moment to the lattice strain was found to decrease with increasing numbers of cycles of alternating stress. However, the decrease was of approximately the same magnitude for specimens stressed above and below the fatigue limit, showing that the change was not associated with fatigue damage. A.

539.389.3 : 539.4.016

8272. Pulse-annealing for the study of relaxation processes in solids. W. E. PARKINS, G. J. DIENES AND F. W. BROWN. *J. Appl. Phys.*, **22**, 1012–19 (*Aug.*, 1951).

The method involves direct heating of a very small sample to a chosen annealing temperature for a short period, followed by rapid cooling to some fixed temperature for an in-place physical property measurement. The method is a very flexible one, as the above cycle may be repeated to obtain any desired time-temperature history. General experimental techniques are described and specific application to graphite and metals noted. The annealing process is examined theoretically. A method is described for deriving the activation energy of the fundamental relaxation process from the isothermal annealing curves of a physical property, the physical property being used as an index of the annealing process. It is shown that the activation energy is derivable without knowledge of the relation between the measured physical property and the fundamental kinetic variable. For further kinetic analysis (determination of rate constants and orders of reaction), however, it is necessary to know this relation. The analysis of isothermal and tempering experiments is compared. A.

539.389.3 : 539.434

8273. On creep and relaxation. III. B. GROSS AND H. PELZER. *J. Appl. Phys.*, **22**, 1035–9 (*Aug.*, 1951).

For Pt. II, see Abstr. 2217 (1948). The previous theory of linear reversible creep is extended and permanent (plastic) deformations are taken into consideration. General relations are established between the distribution functions of relaxation times of stress, and retardation times of strain. A particular type of distribution function is considered in detail and it is discussed in a qualitative way how the existence of a plastic component in creep affects the distribution function of relaxation times. A.

539.4.011.25

8274. The moving Griffith crack. E. H. YOFFE. *Phil. Mag.*, **42**, 739–50 (*July*, 1951).

The stress field is calculated about a straight crack moving through an elastic medium. The stresses depend on the velocity and reduce to Inglis' solution when the velocity is zero. The results may be applied to the spicular fracture of glass. A.

539.411.5

8275. Resistance to deformation of metals at velocities 10^{-6}–10^{2} m/sec. III. F. F. VITMAN AND N. A. ZLATIN. *J. Tech. Phys., USSR*, **20**, 1267–72 (*Oct.*, 1950) *In Russian.*

For Pt II, see Abstr. 5713 (1949). Results of experiments with Cu, Zn, Al and Sn again confirmed the existence, in the range covered by the tests of variations of temperature and velocities of 3 separate ranges of variation of these parameters within each of which one definite mechanism for the influence of velocity on the resistance to plastic deformation predominates. In post-recrystallization conditions of deformation the tests fully reproduced the conditions previously found in experiments with Pb and corroborated the equation representing them, viz. $H_K = H_{K0}(\dot{\varepsilon}/\varepsilon_0)^{m(T-T_0)}$. On the other hand, in pre-recrystallization deformation of the soft metals mentioned the temperature relation was not fully brought out to satisfy the expression previously found for it, viz. $H_K = M(\dot{\varepsilon} \exp N/T)^n$. The results of this test series, just as the previous experiments with Pb, showed that the kink on the characteristics of the deformation resistance *v.* speed at temperatures exceeding the recrystallization temperature corresponds for all the metals to approximately the same resistance value independent of speed and temperature. B. F. KRAUS

539.43

8276. Analogy between the rupture of methyl methacrylate and that of metals by fatigue. F. ZANDMAN. *C.R. Acad. Sci., Paris*, **238**, 20–1 (*July* 2, 1951) *In French.*

A brief statement of the observed stages leading to fracture, for different stress systems, using photoelastic methods. A. J. KENNEDY

539.50

8277. On the use of convected coordinate systems in the mechanics of continuous media. A. S. LODGE. *Proc. Camb. Phil. Soc.*, **47** (*No.* 3) 575–84 (1951).

539.621 : 541.183.5

8278. Friction of clean metals and the influence of adsorbed films. F. P. Bowden and J. E. Young. *Proc. Roy. Soc. A*, **208**, 311–25 (*Sept.* 7, 1951).

An experimental study has been made of the frictional behaviour of thoroughly degassed metal surfaces. An apparatus is described, in which friction can be measured at any desired temperature up to 1 200°c or more, either *in vacuo* or in a particular gas. It is found that when sufficiently clean metals are allowed to touch, even at room temperature, complete seizure occurs. Over the real area of contact the specimens adhere with the bulk strength of the metal, and this area increases greatly with continued sliding or attempted sliding. Various gases and vapours have been adsorbed on to the clean specimens, and their influences on friction determined. These specific contaminants are most effective as lubricants where they can react with the metal to form a solid and chemically attached film which is several molecular layers in thickness. Otherwise the friction remains very high, although seizure is prevented. It is shown that physical adsorption may occur in addition, with a significant reduction in the friction. The results support the view that the friction of metals is due mainly to adhesion at the points of real contact, and is governed by the extent to which even the thinnest of surface films can reduce this metallic contact. A.

539.67

8279. Internal friction of solids. G. Bradfield. *Nature, Lond.*, **167**, 1021–3 (*June* 23, 1951).

A report on the contributions by various speakers at a meeting held in London, March 15th, 1951. A summary of the causes and properties of the principle types of internal friction of solids is followed by accounts of several current theoretical and practical investigations on the subject, particularly on the internal friction due to the motion of dislocations.

A. D. LE CLAIRE

PHYSICAL CHEMISTRY 541

541.1

8280. The structure of physical chemistry. C. N. Hinshelwood. *Oxford University Press* (1951) 476 *pp.*

An account of physical chemistry, not in the nature of an advanced monograph describing the present boundaries of research, but rather a broad survey which lays especial stress on the development of ideas and emphasizes the logical structure and continuity of the subject. R. F. BARROW

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.115

8281. The heat of oxidation of manganous ion to permanganate and the manganese potentials. Z. Z. Hugus, Jr, and W. M. Latimer. *J. Electrochem. Soc.*, **98**, 296–8 (*July*, 1951).

The heat of reduction of permanganate ion to manganous ion has been measured calorimetrically, and this datum combined with other known heat and entropy values to calculate the standard potential relating these states. Literature values for other manganese potentials are discussed and potential diagrams presented for acid and basic solutions. A.

541.126

8282. A study of the reactions that lead to "knock" in the spark-ignition engine. D. Downs, A. D. Walsh and R. W. Wheeler. *Philos. Trans A*, **243** (*No.* 870) 463–524 (1951).

Three experimental techniques were used to elucidate the nature of chemical reactions in the last part of the charge to burn, which previous work has shown to be the factor determining the occurrence of "knock": (*a*) gas-samples were taken at various stages in the combustion cycle by a new type of electro-magnetic gas-sampling valve; (*b*) the effect of additives on the knock-limited compression-ratio was examined; (*c*) the limits of hot and cool flame formation in a motored engine were studied by visual observation of the burning process in the cylinder. Gas-sampling showed that for high-paraffinic fuels, organic peroxides are formed in 2 stages, (i) 1° after top dead centre of the stroke, (ii) 7° after top dead centre; in stage (ii) formaldehyde is also formed. Using CH_4 and C_6H_6 as fuels, the peroxide formation was greatly reduced. This difference in the behaviour of the high paraffins and CH_4 and C_6H_6 was repeated in different effects from the same additive: e.g. addition of NO_2 had a strong pro-knock effect on CH_4 and C_6H_6, but only a slight effect on the paraffins, while formaldehyde is strongly pro-knock for CH_4 and C_6H_6, but anti-knock for the paraffins. Cool flames were observed in the higher paraffins under conditions simulating those preceding knock, but not in CH_4 and C_6H_6. It is concluded that normal (high-paraffin) fuels knock by a low-temp. combustion process characterized by peroxide formation and two-stage ignition, whereas in methane and benzene knocking is a high-temp. single-stage process. A. SCHOFIELD

541.126

8283. Influence of fuel richness on the critical volume-compression ratio for detonation, and comparison with experimental results. B. Salé, M. Serruys and R. Vichnievsky. *C.R. Acad. Sci., Paris*, **232**, 2187–9 (*June* 11, 1951) *In French.*

It is assumed that knock arises from self-ignition of the final layers of charge to burn; and it is known from previous work that self-ignition depends mainly upon final pressure, and not greatly upon mixture strength, except in so far as it affects the final pressure. The final pressure in the cylinder is calculated, allowance being made for the presence of burnt gas from the previous stroke. Knowing the highest useful compression ratio (h.u.c.r.) for one fuel

mixture, the h.u.c.r. for another mixture is taken to be that for which the final pressures are equal. Estimates of h.u.c.r. for mixtures of iso-octane and heptane over the richness range 0·834 to 1·25 (taking richness = 1 as a known standard of comparison) agree with experiment to better than 4%.

A. SCHOFIELD

541.126

8284. On the propagation of flames in gaseous mixtures. H. GUÉNOCHE. *C.R. Acad. Sci., Paris*, **232**, 2316–18 (*June* 18, 1951) *In French.*

Movement of the unburnt gas ahead of a flame in hydrocarbon-oxygen mixtures was examined by photographic recording of the axial displacement of a thin transverse heated gas layer. Neither the experimental technique nor the results of individual experiments are described in detail. It was found that a disturbance is always propagated from the point of ignition, which travels ahead of the flame with approx. sonic velocity; similar disturbances arise when the flame itself changes velocity. Ahead of a steady flame in a closed tube the unburnt gas is at rest, but when the tube is partially open, the unburnt gas travels at a steady velocity dependent upon the dia. of the aperture. When the flame is unsteady, the motion of the unburnt gas is vibratory. The results obtained are briefly discussed in relation to the mechanism of gaseous combustion in tubes. A. SCHOFIELD

541.126

8285. Initiation and propagation of explosion in azides and fulminates. F. P. BOWDEN AND H. T. WILLIAMS. *Proc. Roy. Soc. A*, **208**, 176–88 (*Aug.* 22, 1951).

Some organic and inorganic azides which can be melted have been prepared. In the solid state the impact sensitivity of these azides is increased by the presence of a grit particle, provided its m.p. exceeds 500°C. In the liquid state cyanuric triazide can be initiated by the adiabatic compression of a gas bubble, but even in the apparent absence of gas bubbles the molten explosive is very sensitive to impact. An investigation of the growth of the explosion from the point of initiation shows that with the organic azides the reaction can begin as a comparatively gentle burning which accelerates rapidly to detonation. There is evidence that the chemical reaction occurring in the slow stage is different from, and is less complete than, the reaction in the detonation stage. The comparison of a range of azides and of fulminates indicates that the ready propagation of the explosion is associated with the covalent character of the molecule. Increasing the pressure of an inert gas, such as N, above the explosive has a marked effect in increasing the propagation of the explosion. Confinement has a similar effect, and the results are in agreement with Yoffe's conclusions from the thermal decomposition of the azides. They suggest that the rapid propagation of the explosion is due to the recombination of excited or atomic N at or near the surface of the explosive. A.

541.126

8286. Thermal decomposition and explosion of azides. A. D. YOFFE. *Proc. Roy. Soc. A*, **208**, 188–99 (*Aug.* 22, 1951).

An examination has been made of the decomposition and explosion of some inorganic and organic azides which, when heated, melt before exploding. Some experiments are also described on calcium azide, barium azide and tetrazene, which explode while they are solid. The explosion of the molten azides is due to self-heating of the liquid. Explosion is facilitated by the presence of an inert gas above the decomposing liquid. During decomposition N is the main gaseous product. It is suggested that the self-heating of the liquid azides is due to the retention of hot products of reaction near the surface. The products of reaction may be either atomic N or excited molecules of N. The possibility is also discussed that the above mechanism applies to the explosion of solid azides. A.

541.126 : 535.33

8287. Kinetics of OH radicals from flame emission spectra. III. Total transition probabilities and the energetic distribution of $OH(^2\Sigma^+)$ and $O_2(^3\Sigma_u^-)$ in the oxy-hydrogen flame. K. E. SHULER. *J. Chem. Phys.*, **19**, 888–94 (*July*, 1951).

For Pt II, see Abstr. 3116 (1951). The energetic distribution of $OH(^2\Sigma^+)$ and $O_2(^3\Sigma_u^-)$ in hydrogen-oxygen flames has been investigated. The measurements were made in the inner cones of these flames burning with various fuel ratios (lean, stoichiometric and rich) at atmospheric pressure. The relative concentrations of the excited species were determined by comparing the calculated equilibrium intensity ratios of $OH(^2\Sigma^+)$ and $O_2(^3\Sigma_u^-)$ with the experimental intensity ratios. The electronic, vibrational and rotational transition moments relevant to this calculation have been computed. The good agreement between the experimental intensity ratios and the calculated equilibrium intensity ratios indicates that the electronically excited $O_2(^3\Sigma_u^-)$ is in thermal equilibrium with $OH(^2\Sigma^+)$. It is possible, therefore, that O_2 is excited thermally in the hydrogen-oxygen flame. A.

541.126 : 539.1

8288. On the problem of the chemical ignition of thermal nuclear reactions. E. SÄNGER. *Z. Naturforsch.*, **6a**, 302–4 (*June*, 1951) *In German.*

The theory of detonations leads one to expect that at the focus of suitable converging cylindrical or spherical shock waves temperatures may rise to values near the threshold of nuclear reactions.

W. J. SWIATECKI

541.12

8289. The significance of the frequency factor in unimolecular reactions. S. W. BENSON. Letter in *J. Chem. Phys.*, **19**, 802–3 (*June*, 1950).

With unimolecular reactions, the exptl. evidence of frequency factors of approx. 10^{13} sec^{-1} cannot be taken as confirming the theory of decomposition of the activated complex through rupture of a single bond. This theory is in contradiction with the Lindemann collision theory of activation. More satisfactory interpretations have been proposed, as, for instance, by Slater [Abstr. 2613 (1948)].

W. R. ANGUS

541.12

8290. Kinetics of ordering in the alloy AuCu. G. J. DIENES. *J. Appl. Phys.*, **22**, 1020–6 (*Aug.*, 1951).

The kinetics of ordering in AuCu has been studied

using electrical resistivity as the index of order. A purely phenomenological analysis of isothermal resistivity-time curves showed that ordering in this alloy is a process characterized by a single constant activation energy of 20 kcal. For further kinetic analysis, it is necessary to transform the raw data into isothermal order parameter-time curves. This was accomplished via Muto's theoretical relation between resistivity and the Bragg–Williams order parameter, S. A consistent kinetic picture was obtained in terms of S, with the ordering process accurately described by a simple third-order rate equation with all the kinetic constants fully evaluated. The usual ln (rate constant) v. $1/T$ plot gave an activation energy of 28·5 kcal in excellent agreement with the phenomenological activation energy. Further experiments showed that the proposed kinetics predicts correctly the response to complex time temperature sequences. A.

541.127

8291. The rate equation of ammonia-synthesis on iron-type catalysts of different composition. R. Brill. *J. Chem. Phys.*, **19**, 1047–50 (*Aug.*, 1951).

Investigations on the rate equation of NH_3 synthesis on Fe catalysts have been carried out. The results agree in a general way with the rate equation of Temkin and Pyzhev. An improvement of this equation is given, which leads to a better agreement between observed and calculated synthesis-rates. Experiments carried out at low temperatures show that the rate equation is the same for the 3 catalysts which have been investigated: (1) pure Fe, (2) Fe containing 3% Al_2O_3, and (3) Fe containing 3% Al_2O_3 and 2% K_2O. By means of the improved Temkin and Pyzhev equation a formal explanation can be given for the results obtained by Love and Emmett on NH_3 decomposition on a singly promoted Fe catalyst between 400 and 450c. A.

ELECTROCHEMISTRY 541.13

541.132

8292. Determination of dissociation constants in a mixture of two weak acids by electromotive force measurements. R. G. Bates. *J. Amer. Chem. Soc.*, **73**, 2259–61 (*May*, 1951).

The simultaneous dissociation of two weak acids in a mixture is considered. An electromotive force method that permits the determination of the product of the two dissociation constants when one is known is described. This method can be applied advantageously in the study of moderately strong acids. To illustrate the procedure, the dissociation constant of acetic acid at 25° is evaluated from e.m.f. data for five mixtures of sodium acetate, formic acid and potassium chloride. The result is in agreement with accepted values. A.

541.133

8293. Measurement of conductivity at high frequencies with solutions of considerable viscosity. A. Carrelli and L. Rescigno. *Nuovo Cim.*, **8**, 308–11 (*May*, 1951) *In Italian.*

Measurements at high frequencies ($\omega = 4{\cdot}39 \times 10^7$) have been made with KCl solutions. By the method employed, determinations of the maximum resonance current, no conspicuous difference of conductivity of these solutions was ascertained for the transition from low to high frequencies, such as found by other authors. A.

541.135

8294. Electric and chemical potentials; different methods of treatment and their relation. S. R. de Groot and H. A. Tolhoek. *Proc. K. Ned. Akad. Wet., Ser. B*, **54**, 42–53 (*Jan.–Feb.*, 1951).

Two methods are discussed for the treatment of problems of conduction of electricity in continuous media (especially electrolytes) in which also flows of matter, conduction of heat and chemical reactions are possible. The two methods differ in the respect that the electric potential and the electric potential energy are included or not in the chemical potentials and the internal energy respectively. It is shown that both methods are physically equivalent. The interest of the comparison of the methods concerns the controversy on the significance of electric and chemical potential taken separately or together. In the second formulation it becomes clear that in the combination ${}_k\tilde{\mu} = \mu_k + e_k\phi$ (μ_k chemical potential of the k^{th} component, e_k specific charge of the k^{th} component, ϕ electric potential), μ_k and ϕ cannot be measured separately as long as no space charge occurs. It can, however, be measured separately from the μ_k, for media that are (nearly) insulating, so that space charge can occur. A.

541.135 : 621.357.1 : 621.396.68

8295. Regulated low voltage supply for electrolysis and other uses. M. L. Greenough, W. E. Williams, Jr and J. K. Taylor. *Rev. Sci. Instrum.*, **22**, 484–8 (*July*, 1951). For abstract see Abstr. 4025 B (1951).

541.135.5

8296. Overvoltage at oxidation-reduction electrodes. J. V. Petrocelli and A. A. Paolucci. *J. Electrochem. Soc.*, **98**, 291–5 (*July*, 1951).

An experimental study has been made of the polarization characteristics of the following oxidation-reduction electrode systems: Fe sulphate, Fe chloride, K ferrocyanide-ferricyanide, and Ce sulphate. Data are presented which strongly indicate that the overvoltage includes an activation overvoltage in addition to that due to concentration polarization. The data are analysed from the point of view of rate processes and it is shown that the electrode behaviour is given by an equation which allows an evaluation of the exchange current density and the transfer coefficients. A.

541.135.5

8297. A study of metallic electrodes prepared by sublimation. B. C. Bradshaw. *J. Chem. Phys.*, **19**, 1026–7 (*Aug.*, 1951).

The relative electromotive force of Zn crystals deposited from the vapour phase in high vacuum was measured and found to be of the order of 100 μV. It is concluded that Zn crystals formed by evaporation of Zn are practically strain-free and, as such, are highly suitable where reversible Zn electrodes are needed. A.

541.135.5 : 536.75

8298. Calculation of the entropy variation relative to the transformation $Zn \rightarrow Zn^{++} + 2\theta$. M. Bonnemay. *C.R. Acad. Sci., Paris*, **232**, 2437–9 (*June* 25, 1951) *In French.*

The variation of entropy for the reaction $Zn \rightarrow Zn^{++} + 2\theta$ is -47 g-mol cal per degree, and is independent of the Zn concentration in Zn amalgam electrodes, being the same for pure Zn. The effect of temperature passes through a minimum when a neutral salt is added to solutions of $ZnSO_4$ for maintaining constant the activity of the Zn^{++} ions.

H. H. HODGSON

541.136

8299. Concerning the temperature coefficient of the emf of reversible galvanic cells operated at variable concentration. J. C. M. Li. *J. Chem. Phys.*, **19**, 1059–60 (*Aug.*, 1951).

The usual form of the Gibbs–Helmholtz equation such as $d\Delta F/dT = -\Delta S$ is limited in its application to reversible galvanic cells where all variables except temperature, which can change the e.m.f. of the cell, keep unchanged when temperature varies. For cells where concentration changes simultaneously with temperature, a form including concentration terms should be used instead. Barieau's idea concerning the confusion in literature is discussed. His "correct reaction" is explained and a method for writing this reaction is evaluated in general. It is found that his idea is only useful to certain cases. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

8300. Action of light on colouring matters and their oxidation. N. R. Dhar. *Proc. Nat. Acad. Sci., India, Sect. A*, **18** (*No.* 2) 65–87 (1949).

A survey of the action of light on the various types of colouring matters and dyes is given. Bašic colours behave as weak reducing agents and are readily oxidized by air in the presence of light, in contrast to acidic dyes and naturally occurring colouring matters, which, being richer in O, are not oxidized as readily. When fluorescent and non-fluorescent colouring matters are oxidized by O_3, H_2O_2 or $FeSO_4$, in alcoholic or aqueous solution, a glow is observed which is more pronounced with fluorescent compounds. The bleaching of the latter is due to photo-oxidation or photo-decomposition. Fading of colours may be due to photo-decomposition, photo-oxidation by air, or photo-reduction by fibre or mordant. Dyes, usually basic dyes, used as photo-sensitizers, perform dual functions, viz. as absorbent for visible light, and for reduction of silver halide. Photographic desensitizers cannot exert the reducing action. 44 refs. H. H. HODGSON

541.14

8301. The disproportionation and combination of ethyl radicals: the photolysis of mercury diethyl. K. J. Ivin and E. W. R. Steacie. *Proc. Roy. Soc. A*, **208**, 25–42 (*Aug.* 7, 1951).

The photolysis of mercury diethyl vapour has been investigated in a static system over a pressure range of 0 to 80 mm and a temperature range of 75 to 200°C. The products were analysed for C_2H_6, C_2H_4, C_4H_{10}, C_4H_8. No significant amounts of H_2, CH_4, C_4H_8 or higher hydrocarbons were found. Rotating sector experiments have enabled a complete determination of the velocity constants of the reactions. Energies of activation and frequency factors for these reactions have been deduced. $E_1 - E_2 = 0{\cdot}8 \pm 0{\cdot}2$ kcal/mole, $E_2 \geqslant 0{\cdot}65$ kcal/mole has been deduced from k_2 at 150°C and the calculated collision frequency. A.

541.14 : 541.127 : 545.827

8302. The kinetics of the photolysis of acetaldehyde. I. The determination of ethane and hydrogen in the reaction products by the use of a mass spectrometer. C. J. Danby, A. S. Buchanan and I. H. S. Henderson. *J. Chem. Soc.* (1951) 1426–30 (*June*).

Ethane and hydrogen have been determined in the products of the high-temperature (300°) photolysis of acetaldehyde by the use of a mass spectrometer. The influence of acetaldehyde pressure and of temperature on their formation has been studied. A.

541.14 : 542.944

8303. Bromination of hydrocarbons. V. Neopentane and hydrogen chain lengths. Efficiency of neopentane as a third body. F. E. Schweitzer and E. R. Van Artsdalen. *J. Chem. Phys.*, **19**, 1028–30 (*Aug.*, 1951).

For Pt IV, see Abstr. 7349 (1951). A direct comparison of the rates of photochemical bromination of neopentane and H has been made, which shows the neopentane reaction to be 94 times faster at 470·6°K. It is shown that neopentane is of the order of 175 times more effective than H in promoting homogeneous Br atom recombination. An estimate of the chain lengths for both photo and thermal bromination has been made, and it appears definite that the chain with neopentane has several hundred links. It is suggested that this is in part the result of a high radical concentration, favoured by the fact that the heat of formation of neopentyl radical is only very slightly endothermic as contrasted with that for methyl radical or H atom. A.

541.15

8304. Quantitative comparison of radiation chemical effects in liquid and gas phases. W. Mund and J. A. Herman. *Bull. Acad. Roy. Belge Cl. Sci.*, **37** (*No.* 4) 333–40 (1951) *In French.*

The polymerization of vinyl chloride liquid and vapour by α-particles is studied quantitatively. The number of reaction chains initiated in each case is approximately the same. C. B. ALLSOPP

541.15

8305. Some effects of temperature, phase and nature of chemical species on halogen atom reactions initiated by radiative neutron capture and by isomeric transition. S. Goldhaber, R. S. H. Chiang and J. E. Willard. *J. Amer. Chem. Soc.*, **73**, 2271–5 (*May*, 1951).

The organic yield of bromine activated by either radiative neutron capture or isomeric transition in liquid CCl_3Br appears to increase slightly when the temperature is lowered from room temperature to the melting-point (−5°), increases abruptly with change

from the liquid to the solid phase at the melting-point and increases slowly with cooling of the solid phase to −80°. The increase in the organic yield is qualitatively parallel to the increase in density of the medium. The distribution of the organic products of the (n, γ) reaction is about 45% CCl_3Br, 35% CCl_2Br_2, 20% higher boiling compounds at both 25° and −80°. Increases in the organic yield with decrease in temperature and/or change of phase occur for the (n, γ) reaction on bromine in CCl_2Br_2, in CBr_4 and in solutions of Br_2 in CCl_4; and for the (n, γ) reaction on chlorine in CCl_4 and in CCl_2Br_2. Low concentrations of bromine present in CCl_3Br during neutron irradiation decrease the organic yield of Br^{80} while low concentrations of α, β-dibromoethylene increase the yield. The organic yield of iodine activated by the (n, γ) reaction in dilute solutions of iodine in saturated hydrocarbons averages about 35% while that of dilute solutions of ethyl iodide in the same solvents is about 50%. A.

541.15

8306. Chemical phenomena in water submitted to ionizing radiations. P. BONET-MAURY. *Bull. Soc. Chim. France, No.* 5–6, 333–8 (*May–June*, 1951) *In French.*

The chemical effects of various ionizing radiations on water are reviewed on the basis of the formation of H and OH radicals. C. B. ALLSOPP

541.15 : 539.166

8307. A cobalt gamma-ray source used for studies in radiation chemistry. J. A. GHORMLEY AND C. J. HOCHANADEL. *Rev. Sci. Instrum.*, **22**, 473–5 (*July*, 1951).

A high intensity is described. The Pb shield was designed to provide safety, convenience and reproducibility in irradiating samples under a variety of conditions. A.

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.182.3

8308. The coagulation and deposition of a stirred aerosol. J. CORNER AND E. D. PENDLEBURY. *Proc. Phys. Soc., Lond. B*, **64**, 645–54 (*Aug.*, 1951).

Langstroth and Gillespie have determined experimentally the rate of change of particle number in NH_4Cl smokes in still and moving air, and have analysed their results into deposition on the walls and coagulation inside the aerosol cloud. It is shown here that the empirical constants describing these processes can be explained on theoretical grounds, both in order of magnitude and as regards their variation with the rate of stirring. A.

541.182.5 : 535.5

8309. Optical properties of zirconium hydroxide gels. C. R. KANEKAR AND K. E. SUBRAHMANIAM. *J. Univ. Bombay*, **19**, 28–34 (*March*, 1951).

Gels were prepared from Na acetate and Zr nitrate, and the depolarization factor and opacity investigated over times ranging from 20 to 50 min. The particles are found to increase continually in size even after gelatinization: the particles show a slight decrease in anisotropy at first, followed by a continuous increase. HCl and HNO_3 have a peptinizing effect, while H_2SO_4 has a coagulating effect. N. CORCORAN

541.183.1

8310. The adsorption isotherm of Langmuir and of Brunauer, Emmett, and Teller for multilayers where $n = 3$. D. C. JONES. *J. Chem. Soc.* (1951) 1464–7 (*June*).

An analysis of the adsorption isotherm of Langmuir and of Brunauer, Emmett and Teller for multilayers, where the number of such layers is limited to 3, is made. The isotherms are shown to change from Type I through IV and V and then to VA as the values of c change from just $> 2{\cdot}16$ to $\sim 0{\cdot}25$. Three is thus the smallest value of n where all the known isotherm types for a limited number of multilayers can be encountered as c varies. At high values of c ($c > 1\,000$) the change of adsorption type from I to IV again occurs in this case. The $x/(V/V_m)$ against x curves are analysed, especially in relation to approximations which hold at low values of x. A.

541.183.1

8311. A new multilayer isotherm equation with reference to surface area. G. D. HALSEY, JR. *J. Amer. Chem. Soc.*, **73**, 2693–6 (*June*, 1951).

Using the London law for the dispersion force causing multilayer adsorption and assuming various exponential distributions of sources for the force, co-operative multilayer isotherms are derived. Under certain circumstances these isotherms yield a surface area comparable to the BET area. Under other circumstances they reproduce, and explain, deviations and pseudo-agreement with the BET treatment. A.

541.183.5 : 537.226.8

8312. The dielectric behaviour of vapours adsorbed on activated silica gel. R. MCINTOSH, E. K. RIDEAL AND J. A. SNELGROVE. *Proc. Roy. Soc. A*, **208**, 292–310 (*Sept.* 7, 1951).

The increase in capacitance of a test cell containing a porous activated silica on the admission of adsorbates such as water, ethyl chloride and butane has been measured. The data confirm the existence of a discontinuity in the slope of the capacitance *v.* volume adsorbed plots. The electrical evidence suggests that two types of film are established for the adsorbates butane and ethyl chloride. The first type of film in each case has a density close to that of liquid state, while the second is a much more dilute film. The position of the discontinuity, which is independent of temperature within the experimental precision, indicates that the occurrence of the discontinuity may be related to the number of adsorption centres rather than to the area occupied by the adsorbed molecule. From further evidence it appears that water and butane are adsorbed on the same centres, while ethyl chloride and water are not. In the case of water it is possible that the difference in apparent polarization along the two sections of the dielectric data might be accounted for by assuming molecules free to rotate in the plane of the adsorbing surface for the first section,

and molecules free to rotate in 3 dimensions along the second. The computation of dielectric constants of adsorbed matter in such systems is discussed, and a method based on considerations put forward by Böttcher for powdered dielectrics is developed. It is emphasized that a knowledge of the density of the adsorbed matter is required for such systems, and a method is devised for determining these density values from the dielectric data which is applicable in the case of non-polar adsorbates. The difficulty of interpretation of the data for such systems shows that dielectric measurements are less helpful in examining the adsorbed state than had been anticipated from earlier investigations. A.

541.183.5 : 541.128

8313. Absolute rate of the chemisorption of hydrogen on reduced copper. T. KWAN AND M. KUJIRAI. Letter in *J. Chem. Phys.*, **19**, 798–9 (*June*, 1951).

541.183.59

8314. Adsorptive properties of ammonium phosphomolybdate. C. TOURNEUX AND C. DEVIN. *C.R. Acad. Sci., Paris*, **232**, 2430–2 (*June* 25, 1951) *In French.*

The micro-crystals of $(NH_4)_3PO_4 . 12MoO_3$ have been found to adsorb from 4 to 8 molecules of H_2O depending upon the method of preparation (and size of crystals). Slight differences in adsorptive power ($\pm$ 3%) have been found in different preparations obtained in the same manner, but the ratios of adsorbability of various adsorbates by two different preparations of ammonium phospho-molybdate were constant to less than 1%. Results are presented, in graph form, of the adsorption of various organic liquids by this adsorbent. F. LACHMAN

541.183.59

8315. New observations on the adsorptive properties of ammonium phosphomolybdate. C. TOURNEUX AND C. DEVIN. *C.R. Acad. Sci., Paris*, **233**, 43–5 (*July* 2, 1951) *In French.*

See preceding Abstr. The adsorption by microcrystals of ammonium phosphomolybdate is not a purely superficial phenomenon: the variations in the adsorptive power are caused not so much by the crystal size as by differences in their homogeneity. Conditions for preparing microcrystals of high and low adsorptive power are described. The interstitial volume of ammonium phosphomolybdate crystals that adsorb 5 molecules H_2O per molecule of the salt is 0·18 as compared with 0·20 for analcite and 0·50 for chabazite (zeolites). The adsorption by the salt has been found to be specific (chemical): it does not adsorb O_2 or N_2 (unlike chabazite) and adsorbs some organic compounds that chabazite does not adsorb. Some organic compounds, particularly alcohols, have been found to change the colour of ammonium phosphomolybdate crystals from yellow to green, apparently because of the reduction of the surface layer of the crystals. X-ray spectra reveal the ionic type of the crystals, and the structure of the anion is shown by the formula $PO_4^{IV}Mo_{12}^{VI}O_{24}^{II}O_{12}^{I}$. The 12 peripheral O atoms (mono-co-ordinated) seem to be responsible for both the adsorption and oxidation. F. LACHMAN

CHEMICAL STRUCTURE 541.4/.6

541.57

8316. Studies of the carboxyl group. I. The geometrical structure. M. DAVIES AND O. THOMAS. *Disc. Faraday Soc., No.* 9, 335–8 (1950).

The various quantitative data on the geometrical structure of the carboxyl group are discussed and marked discrepancies are indicated. A structure is proposed which is in much better accord with the range of results available than is the case for previous models. A.

541.57

8317. Studies of the carboxyl group. II. The potential function of the formate ion and the formic acid molecule. O. THOMAS. *Disc. Faraday Soc., No.* 9, 339–50 (1950).

A complete assignment of the in-plane vibrational frequencies of formic acid and the formate ion is made. Generalized quadratic potential functions for these structures are first evaluated by treating them as three-particle systems. The extreme solutions possible with that simplification are taken to indicate the limiting range of the conventional valence-force constants. Four-particle treatments are carried out using Torkington's [A], [e] and [h] matrices to arrive at the force-constant matrix [d]. The significance of the force-constants deduced is discussed. An apparent inconsistency between the carbon-oxygen bond orders as indicated by their lengths and force constants remains. A.

541.57

8318. Interaction intensity in single, double and triple carbon-carbon bonds. S. SENENT AND M. AGUILAR. *An. Real Soc. Esp. Fis. y Quim.*, **47A**, 111–24 (*May–June*, 1951) *In Spanish.*

The method proposed in a previous paper [Abstr. 6547 (1951)] is applied to the quantitative study of the interactions σ and π of single, double and triple bonds in carbon atoms, confirming quantitatively that the highest interaction-intensity corresponds in the single bond to the triangularly hybrid one and in the triple to the carbon hybrid in lineal form. Comparison with the thermochemical constants of carbon brought satisfactory results. A.

541.57

8319. Orbital hybridisation and some other considerations concerning the transition state of bimolecular organic substitution reactions. V. GOLD. *J. Chem. Soc.* (1951) 1430–7 (*June*).

The plausible orbital hybridizations in the transition state of bimolecular organic substitution reactions can be divided into two classes: (i) those in which a *p*-electron contributes to the binding of three atomic centres, and (ii) those in which only two-centre binding by electron pairs need be postulated. The first category is approximated by the case of substitution at a saturated carbon atom, and the second one by that of aromatic substitution. Substitution at the carbon atom of vinyl or carbonyl groups probably involves an intermediate structure about which it should in principle be possible in some cases to adduce more exact information by stereochemical experiments. A.

541.62

8320. Evolution of the transformation of a pure substance in solid solutions and in double salts. B. Cochet-Muchy and R.-A. Paris. *C.R. Acad. Sci., Paris*, **232**, 2096–7 (*June* 4, 1951) *In French.*

Presents some new results on polymorphic transformations of ammonium salts in solid solutions NH_4I–KI and $(NH_4)_2SO_4$–NH_4NO_3, and in the double salt $(NH_4)_2SO_4 . Na_2SO_4 . 4H_2O$.

F. LACHMAN

LABORATORY APPARATUS 542.1/.7

542.77/.78

8321. Electromagnetic mercury pumps for circulating gases. I. E. Puddington. *Canad. J. Techn.*, **29**, 311–16 (*July*, 1951).

Designs for two gas circulating pumps are described. In one of these, bulbs are attached to each end of a U tube, and mercury is made to flow alternately from one bulb to the other through the U thus forming a liquid piston. This may be used either as a double or single action pump. In the second design, which is also a modified U tube, the mercury is circulated continuously in one direction. Gas is entrained between slugs of mercury as it flows externally from one arm of the U to the other to complete the cycle. Circulation speeds of 600 to 800 cm^3 of gas per minute can readily be obtained with either of these models. In both designs the mercury is pumped electromagnetically. The small space requirements and the absence of mechanically moving parts are desirable properties of these pumps. A.

CHEMICAL ANALYSIS 543/545

543.712/.812 : 537.226.2

Moisture determination by dielectric measurement. *See Abstr.* 7840

545.37 : 621.317.727

8322. Auxiliary circuits for pH meter. G. P. Burn. *Electronic Engng*, **23**, 272–3 (*July*, 1951).

Describes the circuits required to provide backing-off e.m.f.'s for zero setting, temperature compensation, etc. The equation for the e.m.f. arising between two solutions is given, and the method of calibration is discussed. W. G. Stripp (R)

545.7

8323. Determination of traces of water vapor in gases. F. E. Harris and L. K. Nash. *Analyt. Chem.*, **23**, 736–9 (*May*, 1951).

The method is based on measurement, with a thermistor bridge, of the temperature rise produced when a stream of the test gas is passed over solid calcium hydride. A single determination requires 5 minutes, and the method may be used for the determination of 0·001 to 0·1 volume % of water vapour. A.

545.8

8324. Detection and estimation of thorium. C. Barcia Goyanes. *Bol. Radiactividad*, **22**, 73–87 (1949) *In Spanish.*

Historical survey of methods. 70 refs.

545.8 : 539.16/.18

8325. Analysis by the use of artificial radioelements and of neutrons. M. Süe. *Bull. Soc. Chim. France, No.* 5–6, D9–D32 (*May–June*, 1951) *In French.*

A résumé of present knowledge, with bibliography (142 references), covering natural and artificial radioelements and their properties and production, separation by co-precipitation, distillation, electrodeposition, ionic exchange, precipitation and chromatography, irradiation by the pile, a list of suitable isotopes and data, and applications of the method to determinations of Ga and Pd in meteorites, the properties of precipitates, solubility problems, the analysis of animal tissues, and metabolism studies. The average sensitiveness of the method is 10^{-8} to 10^{-10} with the piles at present available. J. Grant

545.82

8326. Radioactive ionization and its application to spectrochemical analysis. E. Sanchez Serrano. *Bol. Radiactividad*, **22**, 278–93 (1949) *In Spanish.*

General applications of ionization by radioactive substances are described, and proposals are made for the improvement of the constancy and reproducibility of the electrical discharges used in spectrochemistry. A.

545.82

8327. Applications of the electronic spectra of pyridine homologues to quantitative analysis and to the measurement of dissociation constants. E. F. G. Herington. *Disc. Faraday Soc., No.* 9, 26–34 (1950).

The difficulty of preparing pure samples of pyridine bases is indicated. The absorption spectra of highly purified samples of pyridine, α-, β- and γ-picoline and 2 : 6-lutidine obtained under different conditions are discussed from the point of view of chemical analysis. The spectra of the vapours over a wide range of pressures at 20°C using cells of length 14·5 cm, 61·2 cm and 153 cm are compared. Special attention has been paid to the effect of small amounts of impurities. The spectra of solutions of these bases in 0·1N sulphuric acid, 0·1 N sodium hydroxide and cyclohexane are recorded. A method for the analysis of a mixture of β-picoline, γ-picoline and 2 : 6-lutidine based on the differences in absorption coefficient of acid and alkaline solutions is described. The dissociation constants of these bases have been determined from the spectra of buffered solutions. A.

545.82

8328. Indirect spectrometry. L. Sacconi. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **10**, 407–13 (*May*, 1951) *In Italian.*

For an equilibrium $AB = A + B$ where AB and A cannot be isolated but have optical absorption bands, the composition and equilibrium constant may be determined by colorimetry or spectrophotometry. To obtain the necessary data for calculation, measurements are made on three different equilibrium states of the system. S. T. Henderson

545.824

8329. Determination of sulfur in petroleum fractions by X-ray absorption. S. W. Levine and A. H. Okamoto. *Analyt. Chem.*, **23**, 699–704 (*May*, 1951).

545.824

8330. Determination of uranium in solution by X-ray absorption. T. W. Bartlett. *Analyt. Chem.*, **23**, 705–7 (*May*, 1951).

545.824 : 548.74

8331. X-ray diffraction patterns of solid aromatic hydrocarbons. L. J. E. Hofer and W. C. Peebles. *Analyt. Chem.*, **23**, 690–5 (*May*, 1951).

For the positive identification of solid crystalline aromatic hydrocarbons, X-ray diffraction analysis is proposed. X-ray powder diffraction patterns of 59 hydrocarbons have been obtained using Fe-target radiation. Impurities sufficient to lower the melting-point by as much as 15°c do not appreciably modify the diffraction patterns. The patterns are very characteristic; those of closely related compounds and even isomers are unique and can be readily identified. A.

545.844

8332. Paper chromatography of inorganic substances. The separating power of the saturating and developing organic solvents. A. Lacourt, G. Sommereyns and G. Wantier. *C.R. Acad. Sci., Paris*, **232**, 2426–8 (*June* 25 1951) *In French.*

A new paper-chromatographic method for the separation of cations (and anions) is suggested in which the developing organic solvent is different from the saturating solvent. Quantitative microgram separations (B from Si and Mo; U from Fe and Al) have been carried out. F. LACHMAN

CRYSTALLOGRAPHY 548

548.1 : 535.312

8333. A simple goniograph. F. C. Frank and D. S. Oliver. Letter in *Research, Lond.*, **4**, 341–2 (*July*, 1951).

The reflections from a crystal or etched crystal face are mapped by immersing the crystal in a liquid contained in a thin glass sphere, approximately at the aplanatic point, and illuminating by a parallel beam of light, when the reflections can be studied on a sheet of paper ⊥ to the beam.

548.2

8334. Evidence for the noncubic high temperature phase of $BaTiO_3$. E. A. Wood. Letter in *J. Chem. Phys.*, **19**, 976 (*July*, 1951).

$BaTiO_3$ crystals grown at 1 200°c from the melt, show thin plates with a twofold axis of symmetry, remnants of a form stable above 1 450°c. c. turner

548.24

8335. Piezocrescence—the growth of Dauphiné twinning in quartz under stress. L. A. Thomas and W. A. Wooster. *Proc. Roy. Soc. A*, **208**, 43–62 (*Aug.* 7, 1951).

It has been found that Dauphiné twinning can be created, modified or, in some instances, eliminated, by the subjection of α-quartz specimens to stress produced by mechanical or thermal means. The experimental observations can be explained in terms of a reversible phenomenon, the growth of one crystallographic orientation out of another under the influence of stress, for which the term piezocrescence is proposed. Plates and bars of quartz have been held at about 400°c while they were twisted or bent by external means or while they were kept in a state of strain by means of a lengthwise temperature gradient. In general, the resulting twin boundaries, as shown by acid etching, approximate to an "ideal" twin pattern which is characteristic of the crystallographic orientation of the specimen and the type of stress applied. A theory of piezocrescence is proposed which depends on the principle that, at any part of a quartz specimen undergoing treatment, the crystallographic orientation developed is that which stores the maximum elastic energy. This leads to the formulation of a twin elastic function which is proportional to the difference between the elastic energies at constant stress of the two parts of the twin. A knowledge of the principal stresses in a given specimen and the appropriate twin elastic function enable the "ideal" twin pattern at each part of the crystal to be predicted. In the majority of the experiments there is agreement between the predicted and experimentally observed twin patterns, and the essential features of the maximum elastic energy theory would seem to be justified. A

548.4

8336. Spatial distribution of traces of strontium in a potassium nitrate crystal. J. Pauly. *C.R. Acad. Sci. Paris*, **232**, 2203–6 (*June* 11, 1951) *In French.*

Nearly all the Sr impurity in KNO_3 crystals grown from aqueous solutions containing $(Sr + Sr^*)(NO_3)_2$ is concentrated near the surface. Inside the crystal the distribution of impurities is homogeneous, the density being proportional to the Sr concentration in the solution. J. A. FRANK

548.527 : 532.78

8337. Crystallization velocity of liquid phosphorus. R. E. Powell, T. S. Gilman and J. H. Hildebrand. *J. Amer. Chem. Soc.*, **73**, 2525–6 (*June*, 1951).

Strongly supercooled liquid phosphorus crystallizes with far higher linear velocities than those that have been reported for other substances. Using an electronic circuit with photoelectric cells, and a liquid column 88 cm long, velocities were measured at initial liquid temperatures from near the melting point down to 21·3°, where the velocity, v, was 210 cm/sec. The results are closely reproduced by the equation $(v\eta)^{\frac{1}{2}} = 1{\cdot}01(44{\cdot}1 - t)$, where η is the viscosity in centipoises, and t the temperature. A qualitative justification is given for this relation. A

548.538

8338. On the epitaxial growth of ferrous oxide crystals by controlled oxidation of iron at high temperatures. J. BÉNARD AND J. BARDOLLE. *C.R. Acad. Sci., Paris*, **232**, 2217–18 (*June* 11, 1951) *In French.*

Oriented growth of FeO on iron crystals had been observed under very low pressures of oxygen [Abstr. 3193 (1951)]. A similar process occurs under slightly higher pressures (10^{-1}–10^{-2} mm Hg); the oriented oxide layers grow to appreciable thicknesses, the rate of growth depending on orientation. X-ray photographs indicate that the oxide layers have uniform compositions. J. A. FRANKS

548.538

8339. The influence of the substrate on the crystallization of very thin Au films. A. COLOMBANI AND G. RANC. *C.R. Acad. Sci., Paris*, **233**, 46–8 (*July* 2, 1951) *In French.*

Continuing previous work [Abstr. 5901 (1951)] the effect of crystalline and amorphous substrates on thin Au films is investigated. The resistivity ρ is measured with minute currents I to minimize parasitic crystallization. The critical thickness t for which ρ neither increases nor decreases with the time is independent of I. The new results confirm and extend those obtained previously. Graphs and electron microscope photographs are given. R. A. WEALE

548.538

8340. Lattice stability and oriented overgrowth. M. SMOLLETT AND M. BLACKMAN. *Proc. Phys. Soc., Lond. A*, **64**, 683–91 (*Aug.*, 1951).

The elastic constants of a two-dimensional ionic lattice, strained to fit on to the cube face of a substrate of the rocksalt type, are worked out. From these constants the stability conditions of the strained layer are deduced. These conditions are studied numerically in a number of selected cases where oriented overgrowth is observed in experiment. The calculations lead to conclusions which are in disagreement with a suggestion of Frank and van der Merwe as to the general mechanism of oriented overgrowth. A.

548.574

8341. On the etched surfaces of nickel single crystals. S. YAMAGUCHI. Letter in *J. Appl. Phys.*, **22**, 983–4 (*July*, 1951).

Electron diffraction and electron microscope photographs of etched single crystals of Ni show etch planes of the forms ⟨100⟩, ⟨110⟩ and ⟨111⟩. A. E. DE BARR

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

8342. On the lattice theory of ionic crystals, in particular the halides of the alkaline earths. P. BRAUER. *Z. Naturforsch.*, **6a**, 255–63 (*May*, 1951) *In German.*

Calculation of binding energy and elastic constants taking account of non-Coulomb interactions (polarization, etc.) between ions. J. R. MADDOX

548.7

8343. Energy levels of *F*-centres. L. PINCHERLE. *Proc. Phys. Soc., Lond. A*, **64**, 648–57 (*July*, 1951).

The energy levels of F- and F'-centres are calculated on a very simple model. The ground state of F-centres is found to be determined mainly by the radius of the hole that represents the missing ion in Jost's model, and to vary only slightly with the dielectric constant. In Tl and Ag halides the long-wave photoconductivity is probably due to F-centres. In PbS the energy levels of F- and F'-centres are much too deep to be responsible for photoconductivity. D-centres consisting of a pair of adjacent missing ions are also investigated: they may act as shallow traps, thereby reducing electron mobilities. A.

548.7

8344. Microscopic studies on beryl crystals. I. Observation of uni-molecular steps. L. J. GRIFFIN. *Phil. Mag.*, **42**, 775–86 (*July*, 1951).

Microscopic methods for observing uni-molecular steps on beryl crystals are described and discussed. Possible causes of the visibility of the steps are considered. A.

548.7

8345. Crystal dislocations. Elementary concepts and definitions. F. C. FRANK. *Phil. Mag.*, **42**, 809–19 (*Aug.*, 1951).

The elementary concepts of crystal dislocation theory—in particular the Burgers vector, perfect and imperfect dislocations, sessile dislocations, extended dislocations, twin and twinning dislocations—are defined in a manner independent of particular crystal lattices or models or special orientations of the dislocation: and it is shown how their essential properties arise, in so far as they are independent of the particular crystal in which they occur. A.

548.7 : 530.145 : 538.569

8346. On the interaction between the radiation field and ionic crystals. K. HUANG. *Proc. Roy. Soc. A*, **208**, 352–65 (*Sept.* 7, 1951).

A symmetric treatment of the interaction between the radiation field and a diatomic ionic crystal with optical isotropy is presented; the explicit solutions of the problem can be readily obtained, which describe all the possible modes of vibration of the combined system of the radiation field and the ionic lattice. An unexpected conclusion is that the optical waves immediately below the infrared dispersion frequency are in fact none other than what are normally considered as the transverse lattice vibrations of long wavelength in the theory of ionic crystals. It is shown that such waves consist mainly of mechanical vibrational energy rather than radiative energy. See also Abstr. 8070 (1951). A.

548.7 : 537.533.92 : 539.27

Study of ionic crystals under electron bombardment. *See Abstr.* 8253

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 8249–54

548.733

8347. Automatic focusing condition for double-crystal spectrometer. R. WILD. Letter in *Rev. Sci. Instrum.*, **22**, 537–8 (*July*, 1951).

The condition, for a low-angle-scattering spectrometer, is: specimen-to-crystal distance = crystal-to-counter distance. A. R. STOKES

548.733

8348. An X-ray microbeam spectrometer and technique of its use. J. S. THORP. *J. Sci. Instrum.*, **38**, 239–41 (*Aug.*, 1951).

A Geiger counter spectrometer technique has been developed for the examination of the textures of small crystalline regions by a microbeam of X-rays. Both scanning and reflection curve measurements are made. The spectrometer and counting equipment are described briefly, and some directional sensitivity properties of the counters are considered. The experimental procedure is discussed. A.

548.733

8349. A new equi-inclination Weissenberg X-ray goniometer. D. S. BEARD, E. G. COX AND G. J. SUTTON. *J. Sci. Instrum.*, **28**, 246–51 (*Aug.*, 1951).

This instrument provides great flexibility for handling abnormal problems without loss of simplicity in normal operation. The oscillation angle can be adjusted to any value between 2° and 240°; the film records from $2\theta = 4°$ to 170° with a camera of 2·75 cm radius; provision is made for fitting larger cameras and special accessories; the maximum inclination angle is 30°. The instrument may be used horizontally or vertically; its special features include a very compact demountable goniometer head of wide angular range and a simple device for setting the layer-line screens accurately. A.

548.735.4

8350. A simplified method of steepest descents. V. VAND. Note in *Acta Cryst.*, **4**, 285–6 (*May*, 1951).

Simplifications can be achieved as shown by Booth [Abstr. 4271 (1949)] if R (a residual function) is taken $= \Sigma_{hkl}|F_0 - F_c|$, where F_0 = the observed structure factor, and F_c the calculated one. Although this implies incorrect weighting, a function is derived, based on this, which is shown to be more suitable for setting up on automatic machines than methods based on a Fourier difference synthesis even though convergence is slower. A. J. KENNEDY

548.735.4 : 518.5

8351. A mechanical-electrical unit for calculating structure amplitudes. F. J. LLEWELLYN. *J. Sci. Instrum.*, **28**, 229–30 (*Aug.*, 1951).

A mechanical-electrical unit for the rapid systematic evaluation of functions of the type

$$\begin{matrix}\sin\\ \cos\end{matrix}\{2\pi hx\} \cdot \begin{matrix}\sin\\ \cos\end{matrix}\{2\pi ky\} \cdot \begin{matrix}\sin\\ \cos\end{matrix}\{2\pi lz\}$$

is described. The accuracy is of the order of 1% for hkl planes up to $h = k = l = 20$. A.

548.735.44 : 518.5

8352. Two uses of the optical machine for the calculation of Fourier series. G. VON ELLER. *C.R. Acad. Sci., Paris*, **232**, 2333–5 (*June* 18, 1951) *In French.*

See Abstr. 5002 (1951). An optical synthesis can be made in which the blackening represents, not the electron density, but its rate of change in a given direction, giving a "relief" appearance. Structure factors and their phases can be obtained from measurements of the densities of photographs of Fourier transforms obtained from the optical machine. A. R. STOKES

548.735.46

8353. Increase of contrast in the Patterson function. J. CLASTRE. *C.R. Acad. Sci., Paris*, **232**, 2461–2 (*June* 25, 1951) *In French.*

The Patterson series can be modified so as to give the square of the Patterson function, and then further modified [see Abstr. 8352 (1951)] so as to give the derivative of this squared function with respect to one co-ordinate. This facilitates the accurate location of peaks. A. R. STOKES

548.736.1

8354. Allotropy of beryllium. A. U. SEYBOLT, J. S. LUKESH AND D. W. WHITE. Letter in *J. Appl. Phys.*, **22**, 986 (*July*, 1951).

Suggests that certain X-ray diffraction lines recently reported [Abstr. 753 (1951)] as being due to an allotropic form of Be were due to BeO and other impurities. A. E. DE BARR

548.736.3

8355. The crystal structure of platinum [di]oxide, PtO_2. O. GOCHE. *Bull. Acad. Roy. Belge Cl. Sci.*, **37** (*No.* 4) 393–6 (1951) *In French.*

Cathode sputtering of Pt in O_2 gives films of PtO_2. By a magnetic field perpendicular to the cathode, the deposit can be confined to a small area on a glass sheet placed parallel to the cathode, and in fact forms an image of the cathode. Electron diffraction shows that all parts of the image consist of the same material, but the intermediate zone gives a clearer pattern than either the centre or the edges. The pattern (12 lines) can be indexed as hexagonal, $a = 1·75$, $c = 2·62$ Å, ±1%. A. J. C. WILSON

548.736.3 : 548.5

8356. The thermal transition in caesium chloride in relation to crystal structure. J. W. MENARY, A. R. UBBELOHDE AND I. WOODWARD. *Proc. Roy. Soc. A.*, **208**, 158–69 (*Aug.* 22, 1951).

X-ray measurements have been made on single crystals of CsCl from 20 to 495°C traversing the transition CsCl (b.c.c.) ⇌ CsCl (f.c.c.) at 469°C. Contrary to previously published statements which were all based on CsCl powder, the lattice expansion of the b.c.c. crystal remains approximately a linear function of temperature to within 1° of the transition point. Above about 380°C the intensity of X-ray reflections decreases more rapidly than the Debye-Waller theory predicts. Tentative explanations are discussed. As the temperature rises intensity measurements show that the mean amplitude of vibration of the Cs^+ ion increases faster than that of the Cl^- ion. Little, if any, correlation is found between the orientation of a single crystal of b.c.c. CsCl and the assemblage of crystallites into which it breaks up above the transition point. The number of such crystallites

formed is small, indicating that the rate of nucleus formation is slow compared with their rate of growth. No "interaction" between the two phases can be inferred from the measurements of lattice spacings. A simple hypothesis is suggested to explain the tendency for CsCl to form distorted single crystals. A.

548.736.4

8357. Sodium metaborate dihydrate, $NaBO_2 . 2H_2O$. J. Krc, Jr. *Analyt. Chem.*, **23**, 806 (*May*, 1951).

Information as Abstr. 5924 (1951).

548.736.442.6

8358. Structure of barium titanate at elevated temperatures. J. W. Edwards, R. Speiser and H. L. Johnston. *J. Amer. Chem. Soc.*, **73**, 2934–5 (*June*, 1951).

The crystal structure has been investigated over the temperature range 200 to 1 372°. The structure remains cubic perovskite throughout this range. Unit cell dimensions were observed as a function of temperature; the 200° value of a_0 is in close agreement with that obtained by Megaw [Abstr. 1055 (1947)]. A.

548.736.5

8359. The crystal structure of sulfamic acid. F. A. Kanda and A. J. King. *J. Amer. Chem. Soc.*, **73**, 2315–19 (*May*, 1951).

X-ray studies show that sulphamic acid crystallizes in the orthorhombic system. The unit cell, comprised of eight molecules, has $a_0 = 8{\cdot}100$ Å, $b_0 = 8{\cdot}049$ Å, and $c_0 = 9{\cdot}228$ Å, all $\pm 0{\cdot}002$ Å. All atoms are in general positions of the space group V_h^{15}–P_{bca}. Analysis of diffraction intensity data by means of Patterson–Harker projections and Fourier refinements established the parameters. Hydrogen parameters were deduced to fit this structure. Interatomic distances within the molecule are: S–N, 1·73 Å; S–O (1), 1·49 Å; S–O (2), 1·47 Å; S–O (3), 1·48 Å (all $\pm 0{\cdot}05$ Å). Bonding conditions are discussed resulting in the conclusion that the acid crystallizes as zwitterion molecules ($NH_3^+SO_3^-$) of a distorted tetrahedral form. Extensive hydrogen bonding of the type N–H . . . O is shown to exist in the structure with each NH_3^+ group entering into five bridging systems. The hydrogen bond distances vary from 2·82–3·07 Å. A.

548.737

8360. The crystal structure of cupric tropolone and the dimensions of the tropolone ring. J. M. Robertson. *J. Chem. Soc.* (1951) 1222–9 (*May*).

A two-dimensional crystal analysis of cupric tropolone has been carried out, making use of the phase-determining power of the Cu atom. The analysis is practically a direct one from the X-ray measurements, and makes only a minimum of reference to the chemical structure. In the final projection, made by the usual Fourier series method, all the atoms (except hydrogen) are clearly resolved, and the bond lengths and angles are worked out. The tropolone ring appears to be an almost regular planar heptagon, with an average carbon–carbon distance of 1·40 Å, indicating strong aromatic character. It is possible to differentiate the O atoms as carbonyl and hydroxyl on the basis of bond-length measurements. The central cupric Cu is coplanar with its four surrounding O atoms, which lie approximately at distances to be expected for covalent linkages of the dsp^2 type. A.

548.737

8361. Structural cyrstallographic constants of saccharin and its Mn^{++}, Ni^{++} and Co^{++} derivatives. M. Font-Altaba. *An. Real. Soc. Esp. Fis. y Quim.*, **47**, 125–32 (*May–June*, 1951) *In Spanish.*

All four compounds belong to the space group $P2_1/c$; their individual lattice parameters are as follow [unit and accuracy not stated]:

	a	b	c	β
Saccharin	9·556	6·853	11·766	103° 47′ 30″
Mn derivative	8·068	16·250	7·825	99° 26′ 24″
Ni derivative	7·909	15·881	7·564	98° 54′ 36″
Co derivative	7·835	15·603	7·430	98° 05′ 03″

The three metal derivatives are isomorphous, and from the differences in the axial lengths it is suggested that the metal atoms occupy the positions (000), $(0\frac{1}{2}\frac{1}{2})$ and their equivalents. Goniometric measurements confirm the angle and axial ratios.

A. J. C. Wilson

548.737

8362. New X-ray evidence on the configuration of polypeptide chains. M. F. Perutz; H. E. Huxley and M. F. Perutz. *Nature, Lond.*, **167**, 1053–4 (*June* 30, 1951).

Oscillation photographs of poly-γ-benzyl-L-glutamate, certain fibrous proteins and haemoglobin show a reflection indicating a spacing of 1·5 Å parallel to the fibre axis, not previously observed. This is additional evidence for the structure proposed by Pauling, Corey and Branson [*Proc. Nat. Acad. Sci., Wash.*, **37**, 205 (1951)]. A similar effect shown by horse methaemoglobin supports Perutz's proposed haemoglobin structure [*Proc. Roy. Soc. A*, **195**, 474 (1949)]. The reflection is also shown by frog sartorius muscle, being strongest when the muscle is stretched.

A. R. Stokes

548.737

8363. Crystal structure of 44′-dihydroxydiphenyl. S. C. Wallwork and H. M. Powell. Letter in *Nature, Lond.*, **167**, 1072–3 (*June* 30, 1951).

From X-ray data the unit cell is monoclinic, space-group $P2_1/c$, and contains two molecules, with their centres of symmetry at 000, $0\frac{1}{2}\frac{1}{2}$. $a = 10{\cdot}5$ Å, $b = 5{\cdot}36$ Å, $c = 7{\cdot}9$ Å, $\beta = 95°$. A. R. Stokes

548.737

8364. Solidification curves and crystal spacings of binary fatty-acid mixtures. M. Fieldes and L. Hartman. Letter in *Nature, Lond.*, **168**, 74–5 (*July* 14, 1951).

The d_2 and d_3 (lateral distances between fatty-acid chains) short crystal spacings, not previously reported, have been determined in addition to d_1 spacings in C_{12}–C_{14}, C_{14}–C_{16}, and C_{16}–C_{18} acid-pairs by X-ray spectrometer. No changes in spacing due to polymorphism were observed. d_2 remained almost constant for all compositions of a given acid-pair, but d_3 showed small changes which are detailed and

discussed in comparison with the phase diagram as determined by Jantzen [*Z. angew. Chem.*, **44**, 482 (1931)]. A. J. KENNEDY

548.74

8365. Secondary elastic scattering in electron diffraction. J. M. COWLEY, A. L. G. REES AND J. A. SPINK. *Proc. Phys. Soc., Lond. A*, **64**, 609–19 (*July*, 1951).

Electron diffraction patterns from films of long-chain paraffins show the effects of secondary elastic scattering of electrons in the form of extra spots, groups of spots, arcs of circles, diffuse bands with sharp edges and forbidden reflections in single-crystal patterns. Examples of such effects are given and analysed to demonstrate their origin in the successive diffraction of electrons from two different single-crystal regions. The modification of the intensities in single-crystal patterns and the appearance of forbidden reflections are treated quantitatively on the basis of secondary diffraction by parallel but non-coherent regions of crystal. Expressions are derived whereby observed intensities may be corrected for secondary scattering when once the scattering efficiency of the crystal has been deduced from the observed intensities of forbidden reflections. The importance of such corrections for purposes of structure analysis is demonstrated in the comparison of two Fourier projections made from a cross-grating pattern of dicetyl ($C_{32}H_{66}$), one using observed intensities and the other using corrected intensities. A.

548.74

8366. Diffraction from a bent crystal. M. BLACKMAN. *Proc. Phys. Soc., Lond. B*, **64**, 625–30 (*Aug.*, 1951).

The diffraction of plane waves by a bent crystal is considered. It is shown that the peak of the diffracted "intensity" can be represented in reciprocal space by an arc, the limits of the arc being the total angle of bend of the crystal. The "intensity" function in reciprocal space has been studied numerically in a particular case, and it is shown that both "intensity" and shape change with order. A.

548.74

8367. Diffraction from a curved linear lattice. M. BLACKMAN. *Proc. Phys. Soc., Lond. B*, **64**, 631–7 (*Aug.*, 1951).

The diffraction of plane waves by a curved linear lattice is studied by calculating the "intensity" in reciprocal space. It is shown that the regions of high intensity are arc-shaped in character. Further, the intensity associated with a particular order of diffraction (considered as a function of the cylindrical radial co-ordinate in a plane parallel to that containing the curved lattice) can be represented by the square of a Bessel function of high index in the neighbourhood of the main peak, but dies off sharply on that side of the peak furthest from the origin. This "cut-off" is characteristic of the total angle of bend as long as this angle of bend is less than 180°. The zero-order diffraction peak is of a different type from the others, but is similar to the peak characteristic of a straight chain except for angles of bend greater than 180°. A.

GEOPHYSICS 55

550.381

8368. The reversal of the permanent magnetization of rocks. L. NÉEL. *Ann. Geophys.*, 7 (*No.* 2) 90–102 (1951) *In French.*

Several physical processes can be conceived, according to which the permanent magnetization of an eruptive rock could be in a direction opposite to the magnetic field (taken as a feeble one) which produced it by thermal effect. Two of these processes call for the properties of ferrimagnetic substances, particularly the fact that when the coefficients of the molecular field have appropriate values, the sign of the spontaneous magnetization changes with increasing temperature. Inversion of permanent magnetization may still appear in a compact mixture of two small-grained ferromagnetic constituents having two different Curie points. The constituent which has the lower Curie point may be magnetized opposite to the externally applied field, by action of the demagnetizing field due to the other constituent. The conditions for this effect are studied; it is shown that it can also take place in sedimentary rocks after certain chemical alterations. It is by no means proved, however, that these processes are actually involved in natural phenomena. A.

550.384 : 523.74

8369. Geomagnetic effects of solar flares. D. H. MCINTOSH. Letter in *Nature, Lond.*, **167**, 985 (*June* 16, 1951).

The H and D changes at Lerwick and Eskdalemuir support McNish's conclusion that the magnetic effects of solar flares correspond to an augmentation of the diurnal variation field, but the V changes are anomalous. This is regarded as indicating a change in the distribution of ionospheric currents. A. T. PRICE

550.384.2 : 551.594.9

8370. Evidence for ionosphere currents from rocket experiments near the geomagnetic equator. S. F. SINGER, E. MAPLE AND W. A. BOWEN, JR. *J. Geophys. Res.*, **56**, 265–81 (*June*, 1951).

Records of magnetic field as a function of altitude have been obtained from total-field magnetometers mounted in two Aerobee sounding rockets. The flights were made 60 miles apart at approximately 89° W longitude, 11° S latitude, or geomagnetic longitude 341°, geomagnetic latitude −1°. In the first the field decreased between 20 and 105 km in accordance with the simple dipole field, while in the second a discontinuity of $4 \pm 0{\cdot}5$ milligauss was observed in the altitude range of 93 to 105 km. These results (1) establish experimentally the existence of a current system in the *E*-region of the ionosphere which is responsible for the diurnal variation of the earth's magnetic field at sea level; and (2) lend strong

support to the dynamo theory of the daily magnetic variation. A.

550.385 : 523.745

Control of geomagnetic activity by solar activity. *See Abstr.* 7465

550.385 : 551.594.51

8371. The theory of magnetic storms and auroras. H. ALFVÉN; D. F. MARTYN. Letters in *Nature, Lond.*, **167,** 984–5 (*June* 16, 1951).

Objections are raised to the Chapman–Ferraro theory of magnetic storms, and its extension by Martyn [Abstr. 3223 (1951)] on the grounds that it ignores plasma oscillations and has not been satisfactorily tested by scale-model experiments. In a reply Martyn points out that Chapman and Ferraro actually initiated the theory of plasma oscillations, and that all scale-model attempts to illustrate other theories have yielded ambiguous results. A. T. PRICE

550.385 : 551.594.51

8372. The theory of magnetic storms and auroras. S. CHAPMAN. Letter in *Nature, Lond.*, **168,** 86 (*July* 14, 1951).

See preceding Abstr. Chapman agrees with Alfvén that geophysical theories should be tested by laboratory experiments whenever it is possible to fulfil the necessary scale relations, and suggests that Alfvén and his colleagues might undertake the experiment to illustrate magnetic storm theory, which he recently proposed [Abstr. 3998 (1951)].

A. T. PRICE

ATMOSPHERE . METEOROLOGY 551.5

551.508.5

8373. The over-estimation error of cup anemometers in fluctuating winds. E. L. DEACON. *J. Sci. Instrum.*, **28,** 231–4 (*Aug.*, 1951).

Experiments made in a periodically fluctuating wind current show that Sheppard and Meteorological Office pattern cup anemometers over-estimate the mean wind velocity roughly in accordance with Schrenk's analysis except that the over-estimation decreases somewhat more rapidly with increase of Schrenk's parameter K than is indicated by the analysis. Changing the cup form from the hemispherical to the conical pattern (other characteristics being constant) results in only a slight decrease in the over-estimation error over a limited range of K. A.

551.508.77

8374. A balloon-borne instrument for telemetering raindrop-size distribution and rainwater content of cloud. B. F. COOPER. *Aust. J. Appl. Sci.*, **2,** 43–55 (*March*, 1951).

551.508.94

8375. A new portable electrometer for the measurement of electrostatic charges by electronic methods. Its application to the measurement of atmospheric potential and to the radiosonde. L. KOENIGSFELD AND F. PIRAUX. *Inst. Roy. Mét. Belg. Mem., No.* 45, *pp.* (1951) *In French.*

A Mazda HL 23 triode with plate as control electrode gives full-scale milliammeter deflections for 20 to 300 V/m. Typical measurements are given with the instrument incorporated in a standard radiosonde.

W. C. A. HUTCHINSON

551.510.535

8376. Effect of vertical transport of ions caused by solar tides in *F*-2 region. D. C. CHOUDHURY. *Indian J. Phys.*, **25,** 1–7 (*Jan.*, 1951).

A solution is obtained of the continuity equation of the electrodynamical theory of tides of Martyn for the night condition ω, neglecting the recombination term. The vertical ionic velocity is assumed to have the general form, i.e. $v = v_0 e^{-\gamma z} . \cos(\omega t + \delta)$ where $\omega = 30°$/hour. Curves depicting the variations of N_{max}, h_{max} and h_{min} with height (reduced), are drawn for values of $\gamma = 0{\cdot}25$, $0{\cdot}50$, $1{\cdot}00$, $1{\cdot}25$ and $1{\cdot}50$. For each value of γ variation curves for the hours $0{\cdot}0$, $1{\cdot}0$, $3{\cdot}0$, $5{\cdot}0$ and $7{\cdot}0$ (from the time of maximum upward drift) have been drawn. Curves for the value of $\gamma = 1$ generally agree with the observed results. A.

551.510.535

8377. Abnormal *E* region ionization. N. C. GERSON. *Canad. J. Phys.*, **29,** 251–61 (*May*, 1951).

Oblique incidence radio observations on sporadic *E* reveal both the movement and geographical extent of these reflection areas. On June 13, 1949, two *Es* centres were observed by this method. The first developed rapidly until it included an area of over 10^6 km^2; the second was much smaller. The velocity of the centre of mass of the first area was about 100 km per hr from the S.E. and of the second, about S.S.E. 270 km per hr from the S.S.E. Drift velocities in the ionosphere obtained by other investigators are of about this order of magnitude. A.

551.510.535

8378. Formation of ionized layers. Influence of the temperature. P. LEJAY AND D. LEPECHINSKY. *C.R. Acad. Sci., Paris,* **232,** 2058–61 (*June* 4, 1951) *In French.*

It is shown that Chapman's theory of the photo-ionization of a gas explains the seasonal and diurnal variation of the properties of the *F*-layer, on the assumption that the temperature of the layer varies with the hour and season. J. M. HOUGH

551.510.535

8379. On some approximate expressions for the refractive index of an ionized medium in the earth's magnetic field. E. ARGENCE. *C.R. Acad. Sci., Paris,* **232,** 2080–2 (*June* 4, 1951) *In French.*

Approximate formulae are obtained which are useful for estimating the electron density of the ionosphere as a function of altitude. A. T. PRICE

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 8067–8

551.510.535 : 621.396.11

8380. Investigations of the spreading of sky-waves. II. W. BUDDE. *Z. Naturforsch.*, **6a,** 238–42 (*May*, 1951) *In German.*

For Pt I, see Abstr. 4922 (1951). The short-period variations in azimuth measurements are now briefly considered in relation to variations in the fine structure of the ionosphere. W. J. G. BEYNON

551.593.55

8381. Contribution to the study of earth shadow. I. J. DUBOIS. *Ann. Geophys.*, 7 (*No.* 2) 103–35 (1951) *In French.*

Contains spectrophotometric work on the earth shadow, from 4 000 Å to 8 600 Å. Curves giving the brightness of anti-crepuscular sky are established as a function of the wavelength for a given height above the horizon and as a function of the height for constant wavelength. The observations are made in a vertical plane holding the sun. From these curves, the author shows that earth shadow, or more exactly "anti-crepuscular arch," is only caused by selective absorption of ozone, for wavelengths corresponding to the Chappuis band. A.

551.593.55

8382. Contribution to the study of earth shadow. II. J. DUBOIS. *Ann. Geophys.*, 7 (*No.* 3) 145–62 (1951) *In French.*

The brightness of anti-crepuscular sky is calculated as a function of the height above horizon of the observed spot, and for several values of solar depression. For all these calculations atmospheric absorption by molecular diffusion, selective absorption by ozone and the absorption by water vapour are considered. The resulting curves are similar to those for the earth shadow, confirming that the phenomenon of anti-crepuscular arch is caused by ozone selective absorption. A.

551.593.7

8383. Spectrophotometric study of the polarization of the light from the blue sky in the zenith from 3 050 Å to 4 500 Å. M.-L. TCHENG. *Ann. Geophys.*, 7 (*No.* 3) 137–44 (1951) *In French.*

Observations made at Arosa (1 800 m alt.) of zenith-sky polarization in the blue, violet and near u.v., for varying zenith distances of the sun, show that the degree of polarization is augmented with increasing wavelength, and zenith distance.

D. R. BARBER

551.593.9

8384. Construction of a photoelectric photometer for sodium *D* line twilight emission study in the upper atmosphere. J.-É. BLAMONT AND A. KASTLER. *Ann. Geophys.*, 7 (*No.* 2) 73–89 (1951) *In French.*

The photometer, sensitive to D_1 and D_2 lines only, enabled the altitude distribution of emitting atoms between 100 and 200 km to be deduced. This distribution does not seem to be an exponential one. A.

551.593.9

8385. A new vibration-rotation band of the molecule OH in the spectrum of the night sky. M. DUFAY. *C.R. Acad. Sci., Paris*, **232**, 2344–6 (*June* 18, 1951) *In French.*

The (7, 1) band of OH at 5 564 Å has been observed and measured on well-resolved night-sky spectrograms obtained with a 2-prism Oojan spectrograph. From measures in the *P*-branch, a value of $\nu_0 = 17\,978{\cdot}5\ \text{cm}^{-1}$ is obtained. The *Q*-branch is masked by the strong [O I] line at 5 577 Å. A warning is given that any spectrophotometry in the region of the 5 577 line will be affected by the overlying (7, 1) band; similarly, measures of the Na doublet at 5 893 Å will be influenced by the superposition of the (8, 1) band of OH. D. R. BARBER

551.594.221 : 621.3.015.5

8386. The approximate mean height of the thunder-cloud charges taking part in a flash to ground. V. J. BARNARD. *J. Geophys. Res.*, **56**, 33–5 (*March*, 1951).

The heights of cloud charges involved in lightning flashes to earth are determined by means of the electrostatic field changes recorded simultaneously at 3 observation stations. For 10 flashes to earth the heights of cloud charges are found to vary between 2·5 and 8·7 km with an average of 5·2 km. The electric moment varies between 41 and 495 Coulomb-km with an average of 182 Coulomb-km.

R. H. GOLDE (R.

551.594.9 : 550.384.2

Evidence for ionosphere currents from rocket experiments near the geomagnetic equator. *See Abstr.* 8370

BIOLOGY 57/59

578.088.2 : 534.23

Bibliography of sonic and ultrasonic vibration: biological, biochemical and biophysical applications. *See Abstr.* 7637

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.014.42 : 621.395.645

8387. A d.c.-a.c. amplifier for use in physiology. H. ASHER. *Electronic Engng*, **23**, 170–2 (*May*, 1951).

Describes with complete circuit diagram a simple amplifier for measuring the voltage generated in the retina in response to a flash of light falling on the eye. The amplifier has 6 push-pull stages working into a pen recorder. A gradual stepping up of the h.v. supply in each stage allows a simple method of direct coupling from the anodes of one stage to the grids of the next. The methods of setting up and backing-off any large applied potential for examination of a small variation of it are described. When a.c. coupling is used, various time constants may be selected and the condensers are always kept charged to the same potential to avoid delay. The general construction is described and electro-retinograms are given for the response of a frog's eye when a light is directed on to it. B. B. AUSTIN (R

612.014.48

8388. Radiation effects on man in space. K. BUETTNER. *Bull. Amer. Met. Soc.*, **32**, 183–5 (*May* 1951).

A brief discussion of the physiological effects of

(1) primary cosmic rays, (2) cosmic ray showers and solar microwaves, (3) solar X-rays and (4) the hypothetical solar radiation postulated to explain the Takata serum reaction. A. C. CLARKE

612.795 : 621.317.39 : 621.317.331

8389. A new skin conductivity and temperature measuring instrument. H. BOUKE. *Elektron*, **5**, 118–22 (*April*, 1951) *In German.*

The surface resistance is measured at 380 c/s between two small plane electrodes under a constant load of about 100 g/cm². A potentiometer including the skin resistance is connected across the output of an oscillator and the developed voltage amplified and rectified. The test voltage is about 0·1 V for resistance values from 1 kΩ to 2 MΩ and 1 V for 2 to 20 MΩ. A 10 mA recorder can be connected to the final amplifier. Temperature is measured by means of a thermistor, the resistance of which is determined in a bridge circuit using the same oscillator and detector as for resistance. Constructional details of the electrodes and a circuit diagram are given.

C. F. BROCKELSBY (R)

612.843.31

8390. Changes in colour sensitivity of the eye with posture. J. N. ALDINGTON. Letter in *Nature, Lond.*, **168**, 86 (*July* 14, 1951).

For a subject lying on one side in the prone position the lower eye becomes red-sensitive as compared with the upper. Changing the side reverses the effect.

R. A. WEALE

612.843.31 : 535.621.1

A psychophysical study of white. *See Abstr.* 8789–90

612.843.5 : 616.7 : 621.317.39

8391. A new electronic apparatus for the measurement of the fusion frequency of flicker. C. FRITZE AND E. SIMONSON. *Science*, **113**, 547–9 (*May* 11, 1951).

The apparatus for production and regulation of flicker is free of vibration and noise, and produces a nearly perfect square wave form of the light stimulus. It is based on the R1131A glow modulator tube whose maximal current produces a bright glow on a circular area of 3 mm dia. The spectral variation shows a maximum at 0·51 μ. The electric circuit used is shown in a detailed diagram; a slight modification renders it suitable for experiments in nerve and muscle physiology. R. A. WEALE

612.843.63

8392. Visual acuity and the normal tremor of the eyes. L. A. RIGGS AND F. RATLIFF. *Science*, **114**, 17–18 (*July* 6, 1951).

Photographic records have been obtained for eye-movements taking place during binocular fixation of one point of unspecified colour and brightness. Involuntary drifts and jerks are generally synchronized, but tremulous movements (up to 90/sec and corresponding to 15″ rotation of the eye) are independent. The significance of the results is discussed [without reference to similar work done in England]: it is suggested that "corresponding points" in binocular vision cannot be identified with a pairing of retinal elements in the two eyes. One diagram and one record are given. R. A. WEALE

612.843.633

8393. On the resolving power of the human eye. K. N. OGLE. *J. Opt. Soc. Amer.*, **41**, 517–20 (*Aug.*, 1951).

Data for one observer are presented for the minimal angle of resolution of two point light sources observed against a background the illumination of which could be varied. Thus, the minimal angle of resolution could be measured for different contrasts between point sources and background. The results show that the minimal angle of resolution, within the range of luminances used, depends primarily on the contrast, irrespective of the level of adapting luminances. A minimal and constant value of the minimal angle of resolution occurs when the contrast is reduced below a fairly critical value. A.

612.85

8394. On the nature of the nonlinearity of the ear. G. HAAR. *Funk u. Ton*, **5**, 248–57 (*May*, 1951) *In German.*

The paper discusses the physical reality of the difference tones produced in the ear by very loud sounds; the nature of the non-linearity of the ear and its dependence on frequency; masking effects and the non-linearity of the ear; the non-linearity of the ear and non-linear distortion proceeding from an electro-acoustic transmission system. A. B. WOOD

612.85

8395. The frequency selectivity of the ear as determined by masking experiments. S. DE WALDEN. Letter in *J. Acoust. Soc. Amer.*, **23**, 481 (*July*, 1951).

Discussion of a recent paper under the above title by Schafer, Gales, Shewmaker and Thompson [Abstr. 8390 (1951)]. Reference is made to the universal resonance curve as given by F. E. Terman (*Radio Engineer's Handbook*, McGraw-Hill, p. 137).

A. B. WOOD

612.85

8396. On the theory of hearing. Process of electric excitation of hearing. D. HAVIS, C. FERNANDEZ AND D. R. MCAULIFFE. *Ann. Télécommun.*, **6**, 197–201 (*July*, 1951) *In French.* Also published in *Proc. Nat. Acad. Sci. Wash.*, **36**, 580–8 (*Oct.*, 1950).

The paper is mainly physiological in character, dealing with a "power of summation" which appears to represent the process of excitation generated by the sensory cells of the cochlea in their different nerve fibres. The authors suggest that their explanation of the phenomenon of hearing may also serve to explain the action of other sense-organs, viz. touch and pressure (vibration, muscular sense and the notion of weight and acceleration). A. B. WOOD

614.89–086.54

8397. Nomograph for calculating shielding for Co^{60}. G. A. BENNETT. *Nucleonics*, **8**, 55–8 (*April*, 1951).

614.898

8398. The dangers of, and protection from, radioactivity. J. W. OTTE. *Bol. Radiactividad*, **22**, 217–77 (1949) *In Spanish.*

Lesions may appear immediately after the impact of radiation or after a latency period. Acute and subacute lesions may become chronic. The suggested

treatment for ulcers is impregnation with boron followed by bombardment with thermal neutrons, to produce alpha emission *in situ*. Chronic lesions often turn malignant. Instantaneous exposure to 10^8 r causes reversible lesions while 600 r are lethal. The medical aspects of Nagasaki and Hiroshima and the genetic risks involved are discussed and a probability curve of survival (and its formula) is given. The relationship of the various radiation units is explained and absorption coefficients of biological material as well as tolerance levels of roentgen, gamma, beta, neutron (fast and thermal), alpha, proton, and other energies are given. The various levels for ingestion and inhalation of radioactive materials are discussed and a useful table has been prepared listing some characteristic data and permissible concentrations of the more important isotopes. Methods of protection are enumerated and a bibliography (up to 1949; 173 items) is annexed. W. SUMMER

614.898

8399. Maximum permissible amounts of radio-isotopes. *Nucleonics*, **8**, 70–5 (*Feb.*, 1951).

Recommendations by the International Commission on Radiological Protection on the permissible amounts of various radio-isotopes that may be taken into or retained in the body. The isotopes considered are Ra^{226}, Pu^{239}, Sr^{89}, $Sr^{90} + Y^{90}$, Po^{210}, H^3, C^{14}, Na^{24}, P^{32}, Co^{60} and I^{131}. See also Abstr. 4013 (1951). L. R. SHEPHERD

614.898

8400. Radioactive dust separation equipment. I. A. L. BRALOVE. *Nucleonics*, **8**, 37–50 (*April*, 1951).

The factors involved in the removal of airborne particles are reviewed. Methods are classified in three groups, settling, trapping or impinging. The effect of particle size on the efficiency of removal is discussed and it is pointed out, for example, that particles $\sim 0{\cdot}3\ \mu$ are the most difficult to remove by filtering. Advantages and disadvantages of existing methods of effecting dilution of airborne active dust are described. These methods include stack dilution, paper matte and deep-bed filters, electrostatic precipitators and cyclone separators. L. R. SHEPHERD

614.898

8401. Radioactive dust separation equipment. II. A. L. BRALOVE. *Nucleonics*, **8**, 60–7 (*May*, 1951).

Discusses techniques and equipment at present under development. Several forms of liquid scrubbers are described. These are inefficient for removing submicron particles but may prove very effective if used in conjunction with methods of increasing particle size either by agglomeration or by condensation of water around the particles. Condensation by steam ejection and by sudden cooling and agglomeration produced by means of sound waves are discussed. L. R. SHEPHERD

614.898

8402. Decontamination of small volumes of radioactive water. R. A. LAUDERDALE AND A. H. EMMONS. *Nucleonics*, **8**, 21–6 (*May*, 1951).

Decontamination of highly radioactive water to an activity level safe for drinking is described. The method consists of passing the water through columns containing steel wool, burnt clay, activated carbon and a mixture of ion exchange resins. Experimental runs with tap water contaminated with $2{\cdot}5\ \mu$c/ml of 60 hr-old fission products, produced a reduction in activity to $< 10^{-4}\ \mu$c/ml, the effluent activities consisting mainly of low-energy beta emitters of apparent half lives, 5 hr, 15 hr and ~ 65 days. The effect of flow rate, resin bed depth and the relative effectiveness of the various components used in the treatment have been studied. L. R. SHEPHERD

614.898

8403. Changes in the total circulating eosinophile count in cyclotron workers. C. MOSES AND M. PLATT. *Science*, **113**, 676 (*June* 15, 1951).

Exposures of about 14 r, which showed only transient leukopenia, caused an increase in circulating eosinophiles from 100 to about 500 per mm^3 for the following 5–10 weeks. A dose of only $0{\cdot}5$ r caused a marked rise, and this count is recommended as a sensitive guide for X- and gamma-ray protection. F. T. FARMER

615.849

8404. Wave mechanics, radioactivity and cancer. R. DAUDEL. *Bol. Radioactividad*, **22**, 88–108 (1949) *In Spanish.*

An exposition of the importance of the electronic interpretation of the physical, chemical and physiological properties of molecules after the mesomeric conception, atomic charges of the electrons, etc. A further effort is made to explain the action of the cancerous molecules of varying complexity. The possibility is indicated of using the radioactive indicators in forming a diagnosis and also as therapeutic agents in certain types of cancer. A.

615.849

8405. Some applications of nuclear physics in medicine. W. V. MAYNEORD. *Rep. Phys. Soc. Progr. Phys.*, **14**, 366–412 (1951).

A general survey of a wide range of applications. The manufacture of radioactive isotopes in the chain-reacting pile is described, and the therapeutic and diagnostic applications of P, I, Fe and Na are discussed. The dosimetry of β- and γ-ray emitters is discussed in terms of the absolute energy units, which alone enable correlation to be made with the previously developed dosimetry of X-ray beams. A review is made of medical applications of machines generating high-energy particles, especially the work of the author with a beta-synchrotron in the region of 20 MeV. The report ends with a section on protection against ionizing radiations. A.

TECHNICAL MATERIALS 66/67

669.018 : 541.123.2

8406. A theory of the α, α′ phases in the Al–Zn system. R. S. LEIGH. *Phil. Mag.*, **42**, 876–82 (*Aug.*, 1951).

In the binary alloys of Al–Zn there exists, above a certain temperature, a mixed crystal region in which the two phases α and α′ both have the same face-centred cubic structure but with different compositions and lattice spacings. It is shown that an explanation for the formation of these phase boundaries is provided by the electronic theory of the elastic properties of Al single crystals. A maximum in one of the shear constants at an electron concentration corresponding to the $\alpha + \alpha'$ region gives rise to a subsidiary maximum in the temperature-dependent part of the free energy, which leads, according to the usual construction, to a mixed phase region. A.

669.018 : 541.123.2

8407. The iron-nitrogen system: the preparation and the crystal structures of nitrogen-austenite (γ) and nitrogen-martensite (α′). K. H. JACK. *Proc. Roy. Soc. A*, **208**, 200–15 (*Aug.* 22, 1951).

The N atoms of nitrogen-austenite occupy up to a maximum of about 1 in 10 of the octahedral interstices of the face-centred cubic arrangement of iron atoms in a completely random manner. In nitrogen-martensite the same proportion of the octahedral interstices at ½, ½, 0 and 0, 0, ½ of the body-centred tetragonal iron-atom lattice is randomly occupied. Nitrogen-austenite and nitrogen-martensite are therefore isostructural with the corresponding iron-carbon alloys. The observed unit-cell dimensions vary with interstitial-atom concentration in the same way as for carbon-austenite and carbon-martensite, and for a given concentration are no smaller than in the latter alloys in spite of the smaller size usually assumed for the N atom. The displacements of Fe atoms from the lattice points of martensite, due to the presence of N atoms are considerably smaller than those for carbon-martensite calculated from X-ray data given by previous workers. The values now found for nitrogen-martensite are consistent with the observed cell dimensions and with a N-atom radius of about 0·7 Å. A modified interpretation of the martensite structure accounts for all the X-ray diffraction data. A.

669.018 : 541.123.2

8408. The occurrence and the crystal structure of α″-iron nitride; a new type of interstitial alloy formed during the tempering of nitrogen-martensite. K. H. JACK. *Proc. Roy. Soc. A*, **208**, 216–24 (*Aug.* 22, 1951).

A new iron-nitrogen phase, α″, occurs as an intermediate in the decomposition nitrogen-martensite ($\alpha' \rightarrow Fe_4N(\gamma')$). Although it is a transition phase, α″ is relatively stable and has a structural unit which contains eight (2×2×2) distorted and expanded body-centred tetragonal units of the original martensite structure. The contents of the unit cell are ideally $Fe_{16}N_2$ with the atoms occupying special positions of space group *I*4/*mmm*. The Fe atoms are displaced from sites occupied in the ferrite lattice by the presence of N atoms which occupy 1/24 of the number of octahedral interstices in a completely ordered manner. Up to one-half of the number of N-atom sites may be vacant. The structure is also simply related to that of Fe_4N, and the mechanisms of its formation from nitrogen-martensite and of its subsequent transformation to Fe_4N are discussed. For a case where solute atoms are separated by such relatively large distances, the ordering observed in α″-iron nitride appears to be unique. The unknown nitride reported by previous workers to be precipitated from nitrogen-ferrite is identified as the α″-phase. A.

PHOTOGRAPHY 77

771.351

8409. The progress of wide-aperture photographic objectives (supplementary comments). B. SEEGERT. *Z. wiss. Photogr.*, **46** (*No.* 1–3) 1–3 (1951) *In German.*

Further to the earlier report [Abstr. 8403 (1950)] a new objective based on the Taylor Triplet, the Schachonar, is described, having an aperture *F*/1·0. The front collective member of the triplet is replaced by three meniscus-shaped positive lenses.

H. H. HOPKINS

771.351

8410. On the brightness-attenuation of photographic objectives. W. DZIOBEK. *Z. wiss. Photogr.*, **46** *No.* 1–3) 3–5 (1951) *In German.*

Schulz and Tiller have claimed to reduce the (cosine)^4 attenuation factor by arranging that the principal rays fall normally on the image plane. It is shown that the claim appears to be invalid. H. H. HOPKINS

771.351

8411. On the brightness-attenuation of photographic objectives. H. SCHULZ. *Z. wiss. Photogr.*, **46** (*No.* 1–3) 6–11 (1951). *In German.*

Reply to a criticism by Dziobek (preceding Abstr.) of a claim by the author and Tiller that the (cosine)^4 factor is reduced to a simple cosine factor if the principal rays are arranged to fall normally on the image plane. It is claimed that the earlier result is valid. H. H. HOPKINS

771.53

8412. Characteristics of the photographic emulsion for different durations of continuous exposure. A. L. KARTUZHANSKIĬ AND P. V. MEIKLYAR. *J. Exp. Theor. Phys., USSR*, **21**, 532–40 (*April*, 1951) *In Russian.*

An apparatus for exposing photographic films from exposure times as short as 10^{-7} sec on to any required

length of exposure was designed. It was found that in the range of exposure times between 10^{-7} and 10^{-5} sec photosensitivity and contrast coefficient of the emulsion do not depend on exposure time. When the exposure time is further increased, the photosensitivity of the emulsion grows up to maximum, which it reaches at about 0·01 sec, and then falls again. The contrast coefficient shows a similar curve, although the maximum lies at a slightly longer exposure. A relation was derived between the value of the contrast coefficient at various wavelengths of the effective radiation with the exposure time. It is also shown that when the developing time is increased, the deviations from the law of mutual substitution in the range of short exposures are reduced, but they increase in the ranges of long exposures. The minimum of the curves of isoopacity shifts then towards the side of the shorter exposures. B. F. KRAUS

771.53

8413. A note on intermediate intensity reciprocity-law failure at and near the optimum in photographic exposure. S. FUJISAWA AND E. MIZUKI. Letter in *J. Opt. Soc. Amer.*, **41**, 560–1 (*Aug.*, 1951).

The failure of the law in this region is partly explained by the fact that the average lifetime of a trapped electron is of the same order as its average neutralization time by the ionic process.

S. T. HENDERSON

771.534.53

8414. A mathematical formula relating photographic blackening and exposure. J. NOAR. *Photogr. J.*, *B*, **91**, 64–6 (*May–June*, 1951).

An equation $S = S_m + AE^B$ has been derived which relates the exposure of the photographic emulsion E and its blackening expressed as a Seidel density S. The most important features of this equation are as follows:—(*a*) The photographic blackening curve is shown to be analogous to a normal curve of growth when a suitable unit of blackening is employed; (*b*) A means is afforded of specifying the characteristics of photographic emulsions which is fundamentally more sound in theory and more precise in practice than the diverse speed and contrast ratings used at present; (*c*) The precision of photographic photometry can be improved by its use. A.

771.534.56 : 771.535

8415. High-intensity reciprocity failure of the internal image. G. C. FARNELL. *Photogr. J.*, *B*, **91**, 60–2 (*May–June*, 1951).

The results of an investigation of the reciprocity failure of two experimental emulsions which formed predominantly internal latent image are described. The most interesting feature is that the internal image itself demonstrates high-intensity reciprocity failure, a result not previously reported in a direct manner. In the discussion it is shown that this effect is consistent with present views on the mechanisms of high-intensity reciprocity failure. A.

771.535

8416. The processes of latent image formation. A. HAUTOT. *Bull. Soc. Roy. Sci. Liège*, **20**, 249–70 (*April*, 1951) *In French.*

Two hypotheses are put forward concerning the primary mechanism for latent image formation in dye-sensitized AgBr emulsions. One of these does not involve the elevation of an electron to the conduction band of the AgBr lattice, as is required in the case of non dye-sensitized emulsions. A discussion of the relative mobilities of charged particles in the AgBr lattice shows that the particles most likely to take part in latent image formation are the conduction electrons, *F* centres (which move through the lattice by electron exchange with vacant anion sites) and interstitial Ag^+ ions. Four possible types of sensitivity centres are described and it is suggested that sensitivity centres are essentially accidents of crystallization which are rendered more effective by chemical maturation. A. C. COATES

771.535 : 531.78

8417. The effect of pressure and friction on photographic emulsions. C. G. GILES AND B. E. SABEY. Letter in *Brit. J. Appl. Phys.*, **2**, 174 (*June*, 1951).

The effects of static loads on X-ray films and nuclear track plates were examined with respect to the size and density of the developable areas so produced. S. T. HENDERSON

771.535 : 534.21

Activation of photographic emulsions by ultrasonic waves. *See Abstr.* 7633

778.31 : 778.6

8418. Photomicrography in colour by transmitted light. R. MCV. WESTON. *Photogr. J.*, *B*, **91**, 50–4 (*May–June*, 1951).

The practical difficulties of photomicrography in colour are discussed, particularly that of exposure estimation. A visual photometer is described which enables exposure times, at all magnifications, to be calculated with reasonable accuracy. Practical results of work done with this instrument are described together with inaccuracies due to a number of causes. Special exposing shutters are mentioned and also a proposed photometer for the dual purpose of exposure estimation and colour comparison at the focal plane. A number of minor causes of errors in colour reproduction are also discussed. The conclusion is reached that, with a suitable photometer and shutter, the variable factors in colour photomicrography by transmitted light at any magnification could be closely controlled and the technique reduced to a purely routine procedure. A.

778.33 : 539.164

8419. Nuclear reaction radiography. M. HILLERT. Letter in *Nature, Lond.*, **168**, 39–40 (*July* 7, 1951).

A sample of an Fe–B alloy was irradiated with neutrons and the α's from the reaction $B^{10} + n \rightarrow Li^7 + \alpha$ recorded on an emulsion pressed against its surface. The B distribution is recorded quite accurately.

W. J. SWIATECKI

778.34 : 539.1

The wire method of loading nuclear emulsions. *See Abstr.* 8182

778.34 : 539.1

The study of highly ionized particles in nuclear plates. *See Abstr.* 8183